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The Welding Engineer

PIONEER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

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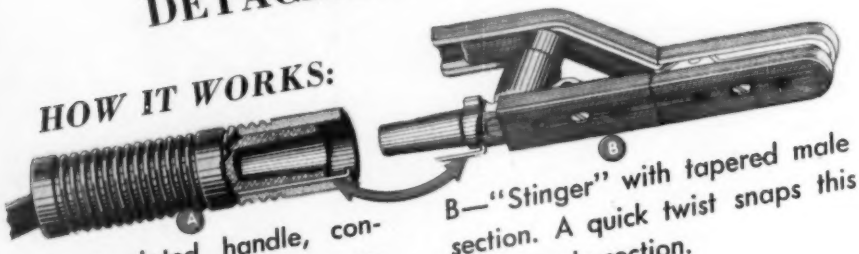

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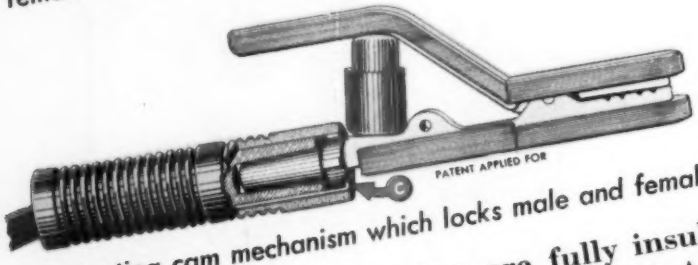

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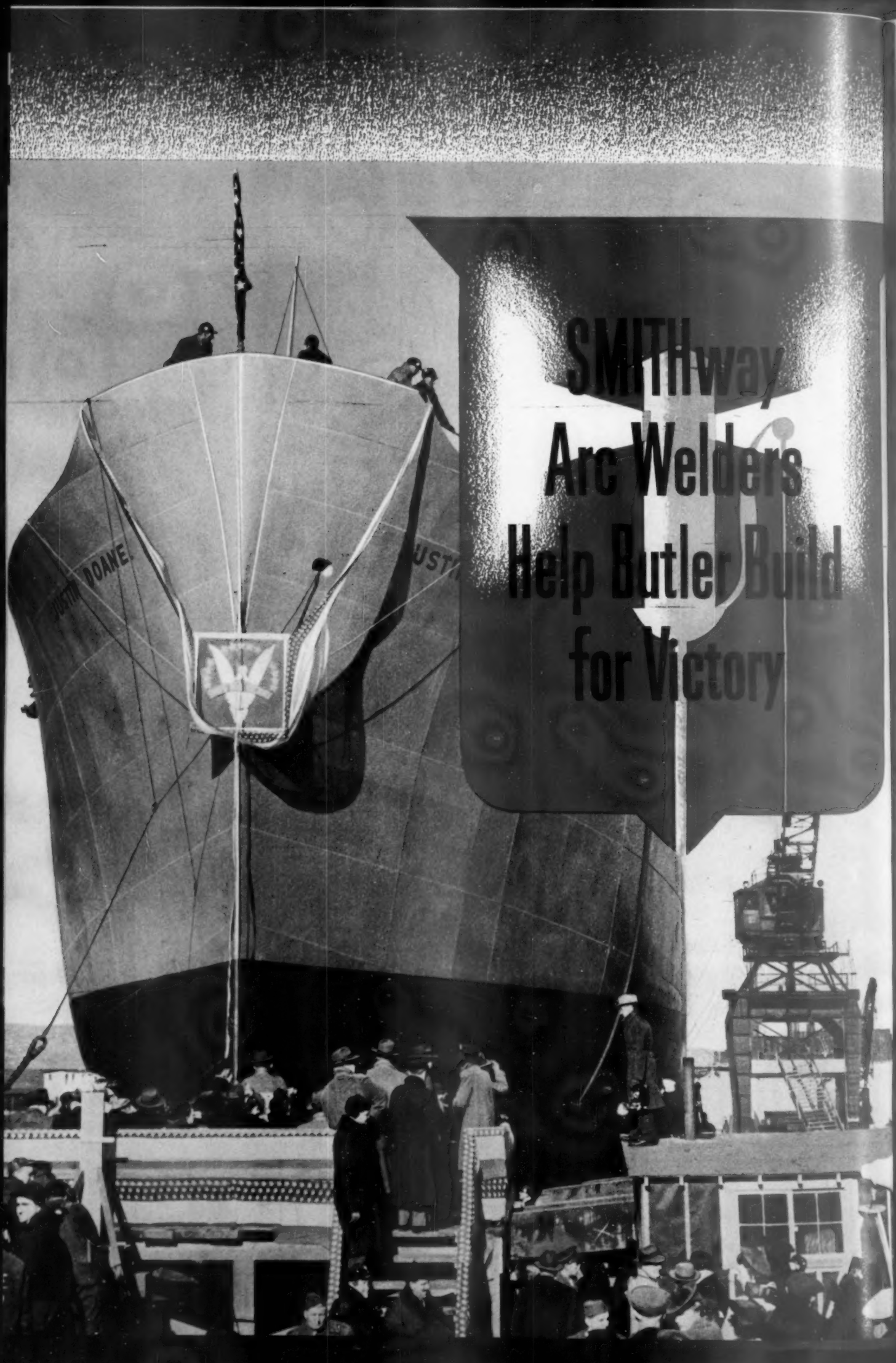
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The Welding Engineer

AMERICA'S PIONEER WELDING JOURNAL

Established 1916

Will Little Business Be Saved?

Welding is small business! Probably no one realizes this more than the job shop operator. But small business embraces more than the job shop. A small business has been defined as one having less than a thousand employees. Such a definition would certainly include most of those in the welding industry.

This definition seems, perhaps, too broad. Not many of us are able to think of an organization employing 999 persons as a "small" business. Regardless of size, however, small business definitely needs help and possibly Congress will act to throw out a lifepreserver.

The final report of the House Committee on small business is encouraging. The committee is awake to the difficulties of business and the means that are being taken daily to further hamstring business with bureaucratic red tape. This was indicated by the opening of the report, which attested to the recognition of these fundamental facts: "The inability of small business men to obtain war contracts constitutes a dangerous and indefensible waste of productive power in the war effort . . . It was clear that the interests of independent small interests had been too long neglected and that legislative assistance was imperative."

The action of the Committee has already resulted in the enactment of some very good legislation. This includes a law for the release of dealers with rationed or "frozen"' inventories on their hands, a law establishing the Smaller War Plants Corporation and a much needed law designed to eliminate requirements for unnecessary and useless information by Federal departments.

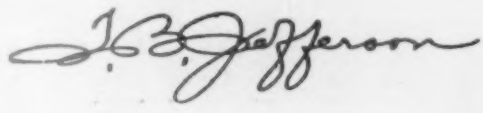
The Committee also contemplates additional helpful laws, one of which is obviously suggested by an investigation of "the extent to which small business has been injured or the war effort impeded by bureaucratic regulations of such war agencies as the Office of Price Administration, the War Production Board, the Office of Defense Transportation, etc."

Encourage your congressman to continue the good work for small business. One of the fundamentals of the republican form of government is "the voice of the people." We elect a member to Congress and then, all too often, expect him to think as we do without letting him know how we think.

Remember that congressmen are influenced by pressure or pressure groups. What Congress needs most today is a pressure group fighting for the middle class—a group that will exert the same influence that has resulted in legislation benefiting the farm, labor, big business and other organized blocs.

Small business—the very backbone of the American way of life—is about to be futilely sacrificed. The war effort will not be benefited by such a sacrifice, it will, on the contrary, be greatly hindered. And the chaos which will follow the cessation of hostilities without the cushioning effect of small business will be almost indescribable.

We must not let this happen. It is the clear duty of Congress to preserve institutions which mean so much to a nation. Do your part by making your own representative aware of his responsibility. Write to your congressman today!



How will *YOU* Answer This Big Question?

So the question is: *"What technical improvements in manufacturing methods, developed in war work elsewhere, could be adapted to our peacetime operations?"*

ALTER EGO: That's it—one of the questions being asked industrialists by the new Committee for Economic Development, urging PLANNING NOW for post-war business.

Well, here's one answer that I've found "elsewhere". This shipyard has boosted the speed of 3/8" fillet welds from 30 ft. per hour to 65 ft. with the "Fleet-Fillet" Technique. We can apply this 111% speed increase to our *peacetime operations* — to cut costs of our products.

ALTER EGO: That's what we want—*lower costs*. But we also want to *improve our welding* so we'll advance on the two fronts on which the Battle for Business will be fought—COSTS and PRODUCT QUALITY.

Let's look to Lincoln for the welding knowledge to put AND KEEP our costs and quality ahead of competition.

Ask your inner self: "What welding improvements 'DEVELOPED IN WAR WORK ELSEWHERE' can profitably be applied to our peacetime operations?"

THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO

Brazing* a 7,100 Hp Turbine Speed Ring

By CLYDE B. CLASON

★ Part I — One of the largest repair jobs to be handled by oxy-acetylene brazing was the reconstruction of a 37,000 lb speed ring for a 5,000 kw generator at the Black Canyon hydro-electric plant, United States Bureau of Reclamation. Brazing effected a swift and economical repair of fourteen broken cast iron vanes.

TURBINE No. 1 at the Black Canyon plant of the United States Bureau of Reclamation was shut down because of a broken speed ring. Naturally the 5,000 kw unit had to be returned to service as quickly as possible; otherwise, the power demand on other equipment would be greatly increased or else customers vitally in need of power for irrigation pumping would not be served. What was to be done?

There were two methods of repair open to the Bureau: (1) the damage could be repaired in place by the most practicable means, or (2) a new speed ring could be obtained.

The second course seemed highly impractical. Foundries were loaded to capacity; unquestionably, delivery would be long delayed. Even if the speed ring order could be placed ahead of other orders, it could be done only at the expense of other turbine jobs, most of which were highly important to the war effort. Likewise, the new casting would call for a large amount of new metal—metal just beginning to be demanded in ever increasing quantities for the nation's armed forces.

Cost of a new speed ring installed would total approximately $15,000, it was estimated, and require around eight months for completion. It seemed much wiser to make the repairs in place. However, a job of this kind had never been undertaken heretofore. Would it be possible to make these repairs by welding?

It was possible. The repair job cost less and was, moreover, completed within five months. The welding itself (a comparatively minor item in the total repair budget) was done in just one month, the rest of the time being employed for preparation and for putting the unit back into service.

Damage Extensive

The Black Canyon is a diversion dam for irrigation. Power produced here is transmitted to other points where it is used during the dry season to pump water for reclamation purposes. The power house contains two 5,000 kw hydro-electric generators and two water turbine pumps.

The break on the speed ring of Unit No. 1 occurred early in January, 1941. Damage was extensive: 14 of the 16 vanes of the ring were broken, either partially or completely in two. The exact cause of the break is unknown since none of the several theories advanced would fit all of the facts involved in this peculiar case.

Unit No. 1 was in operation at the time the break occurred. A definite noise was heard, and then water was found in the lubricating oil. The generator was temporarily shut down, and the oil filtered to remove the water. When an examination failed to reveal any damage, the unit was re-started.

Fifteen minutes later, it was observed that water was issuing from several points of the generating unit, and it was also noted that the concrete had raised from the floor. The generator was shut down once more and was not operated again until July, 1941.

The decision to braze the large casting was reached in the Denver office of the Bureau of Reclamation after a consultation with the Denver office of The Linde Air Products Co. Repairs by other methods were considered, including the use of other welding processes. It was soon determined, however, that these methods were impractical because of the cramped working conditions or because the materials involved were not suitable for use in overhead welding applications.

*Brazing is defined by the American Welding Society as: "A group of welding processes wherein the filler metal is a non-ferrous metal or alloy whose melting point is higher than 1,000 F but lower than that of the metals or alloys to be joined." This process is also referred to as "bronze-welding" in some instances.

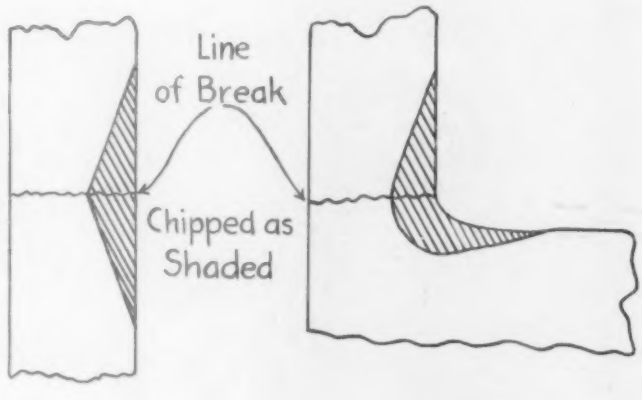


Fig. 1—Prior to brazing, the breaks were chipped as shown in the shaded areas of this diagram. Chipping was varied to accord with the type of break.

Fig. 2—An air-operated chipping hammer greatly facilitated the preparation of the vanes for brazing. Note the completed chipping on the upper corner of the center vane.

Specifications

The Bureau's specifications called for a rectangular-shaped strip of welded metal, ½ in. deep and 2½ in. wide, extending as an inserted band completely around each broken stay vane. Such a repair, it was stated, would provide approximately the same strength as the original cast iron vane. The same type of weld was to be applied outside and inside the circumferential cracks in the upper speed ring.

The welds, the Bureau further stipulated, were to be deposited in layers. Each layer was to be applied slowly in order to minimize heat distortion, and each layer was to be peened in order to reduce the locked-up stresses and to insure a dense, compact deposit.

The complete repair job involved:

(a) Removing of the turbine, generators and broken concrete around the scroll casing. This work was done by Bureau of Reclamation employees.

(b) Placing high-strength stay bolts through the cored holes in all stay vanes. These bolts were used to pull the vanes closed to normal position and thereby assist the welded vanes to resist the internal hydrostatic pressure in the casing.

(c) Chipping out the broken joints in the stay vanes and upper speed ring lips to a depth of ½ in. and for a distance of 1¼ in. to each side of the crack.

(d) Brazing. The Bureau stipulated that the welds were to start at the bottom of the chipped groove and were to be built up to the full depth on each side of the crack.

The task of repairing the damaged speed ring was started in February. By April 29 the unit had been completely disassembled and the vanes pulled into place so that the broken sections were then ready for welding.

Fig. 3—Two vanes are now ready for brazing. A double crack caused a portion of the center vane to fall out, leaving a hole.

Preliminary Steps

Before welding could be started, however, many preliminaries were necessary, and several difficult problems arose before the job was completed.

One of the first of these pertained to the selection of the method of veeing out the cracks, Fig. 1. This could be accomplished either by flame-cutting or by chipping. Chipping seemed to be the more practical method in this instance, and the veeing of the cracks for welding was done with air-operated chipping tools, Fig. 2.

The vee openings were not chipped until after the stay bolts had been placed through the holes in the vanes and had pulled the casting into the proper place. The work was in general chipped as shown in the shaded portion of Fig. 1, which serves to illustrate examples of both straight-through and corner breaks. General-

Fig. 4—Contraction was prevented by 25 ton jacks placed between the upper and lower flanges of the speed ring. The "shiny" shaft was centered in the casting and was used to measure radial movement.

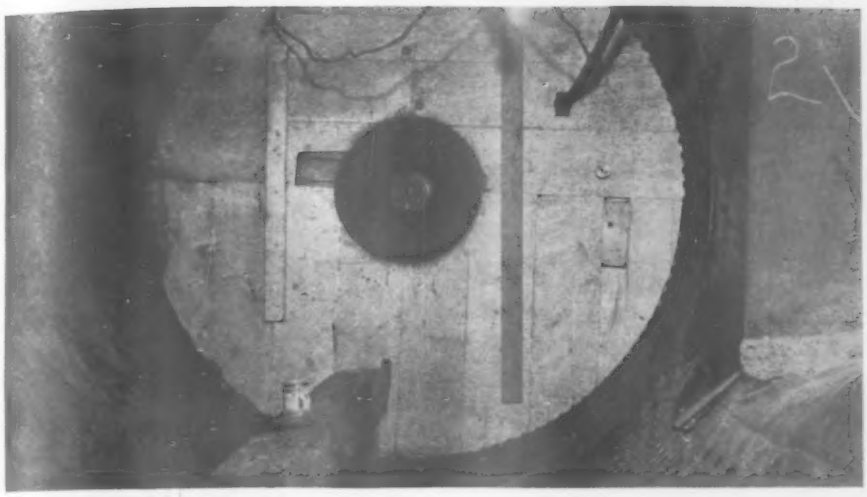


Fig. 5—A ventilating fan was centered in a bulkhead in the turbine scroll to insure an adequate supply of fresh air.

Fig. 6 (right)—Brazing a vane. This picture, taken through an entrance manhole, shows the oxygen and acetylene hoses (upper right) and an air hose (lower left) for chipping and ventilation purposes.

ly, the base metal was chipped away to a depth of ½ in. and 1¼ in. each side of the crack. Drawings were made, and the men doing the chipping were encouraged to follow these drawings as closely as possible.

In Fig. 3 are shown two vanes that are ready for brazing.

Jacks and Preheating

The space between the upper and lower wearing plates of the wicket gates was supposed to be 29.5 inches, and about 0.020 in. extra was wanted for clearance. Anything between 29.515 and 29.525 in. was held to be satisfactory. Originally it was specified that the welds were to be made with the breaks tight together, allowing no expansion. However, it took only half a weld, with a subsequent break opening of 0.04 inch, to prove that some expansion release was necessary.

The following procedure was finally worked out:

A measurement was first taken between the wearing plates, after which the upper and lower lip sections of the speed ring were spread to 29,570 in., or close thereto, with 25 ton jacks (see Fig. 4). This gave about 0.050 in. to work in. To obtain the clearance, the jacks were sometimes pulled so hard that ratchet dogs or teeth from ratchet gears were sheared off.

Preheating was also resorted to as an aid to jacking. The vee openings were preheated locally with the welding torches. Also, the previously welded vane was preheated over its entire surface to approximately 200 F—a temperature at which it was just too hot to rest the bare hand upon the vane.

The compound curves of both vanes and lip sections simplified preheating since most welding was, in effect, done on projecting lugs.

Blower Fan Necessary

Before welding could begin, ventilation had to be considered. It was realized that this would be the most difficult of the several problems peculiar to this job. Fresh air had to be forced through the penstock by means of the largest blower it was possible to install, Fig. 5. Moreover, operators working inside the vane circles had to wear fresh-air masks. Fig. 6 shows an air hose entering a manhole.

Though the blower was necessary in order to remove the fumes and to keep the area where the men worked at comfortable working temperature, it naturally increased the preheating problem. Heated vanes had to be wrapped in asbestos in order to lower the heat loss. Further to direct the air, canvas curtains (Fig. 7) were hung around the outside of the vanes. These forced the air to go inside the vanes and exhaust through the main building.

None of the men suffered on account of zinc fumes, although chippers could not work while the welding was in progress.

* * *

The author wishes to thank B. H. Higgs, The Linde Air Products Co., Salt Lake City, and the Bureau of Reclamation, Denver, for much of the information contained in this article. Acknowledgment is also made to The Linde Air Products Co., New York City, for the photographs.

(Part 2, the actual welding job, will appear in an early issue of THE WELDING ENGINEER.)

Fig. 7—Horizontal brazing of a vane. Two welders worked on this vane. The curtain (right) directed the ventilating air to insure good circulation.

Training Soldiers to Weld

Soldier-weldors are taught the use of both oxy-acetylene and electric arc equipment at the Quartermaster Replacement Training Center School, Camp Lee, Va. This trainee is watching an instructor demonstrate the correct and safe manner of handling an electrode.

U. S. Army News Photo

Teaching maintenance weldors their trade has become "big industry" at the Army's Blacksmith and Welding School, Camp Lee.

EVEN to the casual observer, transportation—or the lack of it—must mean ultimate victory or defeat. For this war, as it is being fought on all fronts today, is primarily a battle of supplies.

Of prime importance in this picture is the weldor, a key figure in the maintenance of the vast number of trucks the U. S. Army is using in both domestic and foreign fields. Little or no imagination is needed to realize the soldier-weldor's part in keeping those trucks going.

A School for Weldors

The soldier-welding specialist receives his training at the Blacksmith and Welding School of the Quartermaster Replacement Training Center, Camp Lee, Va., commanded by Brigadier General Guy I. Rowe. At the welding school, which is in charge of Captain J. L. Bauer, the trainees are instructed in blacksmithing and in both oxy-acetylene and electric arc welding.

When the weldor graduates, he is turned over to Ordnance, where he may find himself called upon to do jobs ranging from heating a bent bumper in order to free it from the tires to repairing a cracked cylinder block.

The Camp Lee trainee is taught to fit in and be capable of doing any type of repair job which may be required. He must be able to offer suggestions. He must learn to take into consideration the service conditions, the strength of the part being repaired, the possible result of failure, the effect of heat and expansion, the effect of welding on prior heat treatment as well as any possible alternate methods of repair.

Light and Heavy Maintenance

After graduation, the weldor may become a member of a light maintenance unit. The light maintenance company, normally serving a division, has three blacksmiths and weldors and includes among its equipment a gas-engine-driven arc welder and a portable forge. The equipment also includes a four-ton repair truck carrying a complete oxy-acetylene cutting and welding outfit. Among his duties with such a unit, he may cut away the debris caused by a wreck or perhaps release drivers or cargo trapped in the wreck. He may also be called upon to weld tie rods, repair tail gates and other parts, to fabricate small parts, make body repairs, make special tools and repair broken tools and equipment. Likewise, he will repair cracked cylinder blocks, heads and manifolds.

The work of the light maintenance unit is apt to be of an emergency nature—just enough to get the vehicle rolling again. Perhaps the soldier-weldor may join a heavy maintenance shop, where work is done of a more permanent and finished character. From this shop, a vehicle is expected to leave practically as good as new. The six blacksmiths and weldors have at their disposal a gas-engine-driven arc welder, a motor-generator type arc welder, two oxy-acetylene outfits and two portable forges.

Humble Beginnings

Captain Bauer has been officer in charge of the Blacksmith and Welding School since its inception at Camp Lee in February, 1941. He came as a second lieutenant from a position as engineer in the maintenance and construction department of the Standard Oil Company of New Jersey. In the early days the shop was an open yard and the office a trailer, with Lieutenant Bauer's own "sticky" (self-described) portable as the only typewriter. In compensation, however, two civilian instructors who were experts in their line were assigned to him as assistants. These were Lyle Jordan, now a commissioned U. S. Army Officer on overseas duty, and Joseph Rutledge, who has since worked on the Burma Road and is now somewhere in the Far East.

Initially, the only equipment consisted of one welding torch and a gas-engine-driven arc welder. Since no buildings were available for the storage of equipment, the first welders were mounted in one-ton trailers and covered with tarpaulins at night. Later, a combination cargo and horse trailer was used as a tool and supply room.

By July, Captain Bauer had accumulated several tents and two huts of the type used by contractors. Long before it was moved into a building, in November, 1941, the blacksmith and welding section was a busy one, with twelve arc welders in use. These were rendered portable by mounting them on chasses made from salvaged parts.

Welding tables and stands for both arc and acetylene welding were made from salvaged material. Many of the trainees proved to be expert weldors, and these men were used as assistant instructors. The classes were divided into two groups, arc and acetylene, the groups being interchanged at the end of a predetermined period. The students were first taught to weld on scrap material and after they became proficient were put on the production of tools and other articles needed for the basic school. Also, many repair jobs were done for the Post Quartermaster, the various motor pools and other organizations.

The Blacksmith and Welding School was assigned its own shop building in July, 1942. The equipment in the main building now comprises 15 gas-engine-driven D-C welding generators and four electrically-driven D-C welding generators.

Fig. 1—Reconditioning a shaft by building up the worn section with a weld deposit. The beads are laid lengthwise and diametrically opposite.

Worn Parts Made New

Four ways by which worn pump shafts and rods may be reconditioned to outlast the Axis. Of these methods, three involve the deposition of metal for building up worn parts and refinishing to their original sizes.

BASICALLY, there are four ways in which worn parts may be restored to new condition. One method, of course, is that of machining and refinishing the part to a slightly smaller size. This method will not be discussed here as it is beyond the editorial field of THE WELDING ENGINEER. The other methods involve the deposition of new metal by three processes—welding, metallizing or metal spraying and electroplating or "cold casting." For purposes of comparison, a worn Monel pump shaft is selected as an illustrative example, and the pictures show this shaft with sections built up by all three processes. The scope of possible applications naturally extends beyond the reconditioning of pump rods and shafts.

The Welding Method

The method which reclaims a rod or shaft with the highest strength, toughness and stiffness is by welding, Fig. 1. This method is also usually the most readily available, for any maintenance shop with electric welding equipment can recondition worn shafts and rods by following the procedure outlined below.

As in any welding job, the surfaces to be built up must be clean. Foreign materials such as grease or particles of packing should be removed by rough machining, grinding, filing, or by wire-brushing.

When building up by welding, the best electrode position for downhand welding is at an incline of about 20 deg from the vertical, ahead of the puddle. This is the most suitable position for controlling the molten flux and eliminating slag inclusions. A short 24-27 volt arc should be maintained during welding. For building up the Monel shaft pictured, a 130X Monel electrode was used.

The recommended electrode sizes

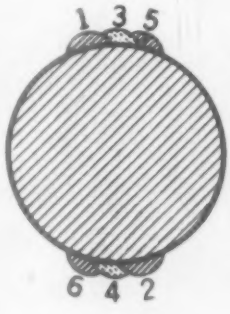
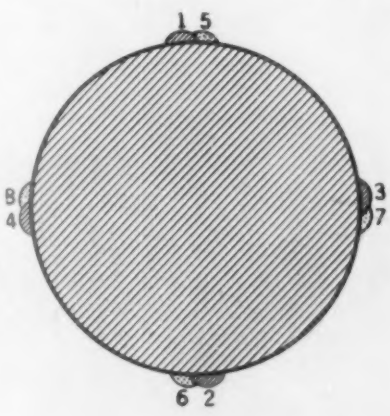


Fig. 2 (left) — Sequence for laying down welding beads on shafts 2 in. in diam and smaller.

Fig. 3 (right)—Sequence for laying down welding beads on shafts of larger diam than 2 in.



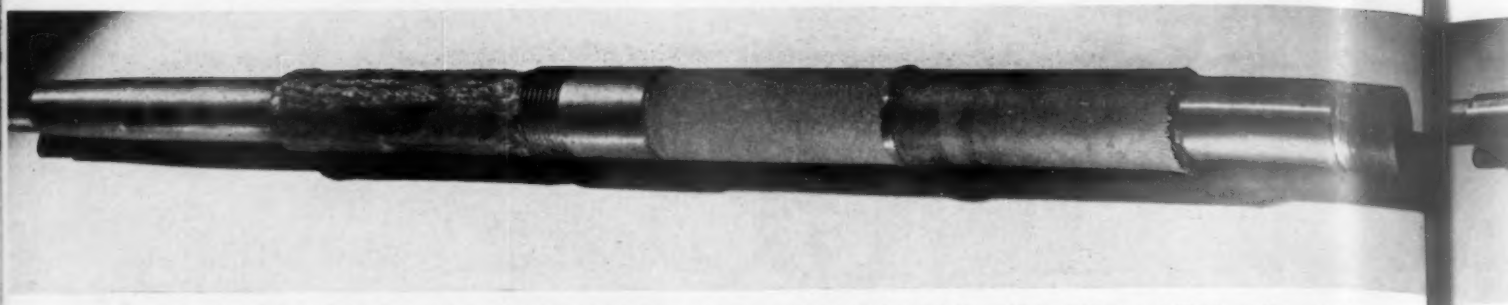


Fig. 4—View of shaft showing three different methods for building up worn sections. Left to right: welded addition, metallized coating and electroplating. This shaft was seen by many visitors when it was on dis play at **THE WELDING ENGINEER's** *booth at last fall's Metal Show.*

and current settings for different sizes of shafts and rods are given below in Table I:

Table I. Electrode Sizes and Current Settings for Building up Monel Shafts by Welding.

Shaft Diam, inches	Electrode Diam, in.	Current Range, Amp
½	0.075-3/32	45-60
¾	3/32 or ⅛	45-60 or 60-95
1	⅛	60-95
1½ or larger	5/32	80-150

It will be noted that the largest electrode listed in this table is 5/32 in. This is not necessarily the upper limit of electrodes that may be used. Where large shafts must be greatly increased in diameter to fit oversize bearings, the welds may be made with 3/16 in. electrodes at 140 to 190 amp or with ¼ in. electrodes at 170 to 260 amp. With these larger electrodes, however, more care must be taken to equalize the heat input at all points on the shaft.

When reclaiming a worn shaft by welding, the chief precaution is to prevent warpage. This can be controlled by keeping the welding heat low and by depositing the welding bead longitudinally along the shaft as illustrated in Fig. 1.

Proper Sequences

In building up shafts smaller than 2 in. diameter, the beads are deposited in a sequence alternating from one side to the side diametrically opposite as is shown by Fig. 2. Each weld should be cleaned of flux and wire-brushed before the adjacent bead is laid.

For shafts larger than 2 in. diameter, the rebuilding is accomplished by depositing beads of weld metal according to the sequence shown in Fig. 3. These procedures tend to equalize the effects of heating and cooling and thus hold the shaft straight. The size of the beads and the welding speed are kept uniform until the worn section has been completely rebuilt to the thickness required for finishing to the final dimensions.

The completed weld build-up, left of Fig. 4, is clean and solid, with close-knit and uniform rows of beads overlapping each other. The shaft is now machined and finished to its final dimensions, Fig. 5.

Metal Spraying

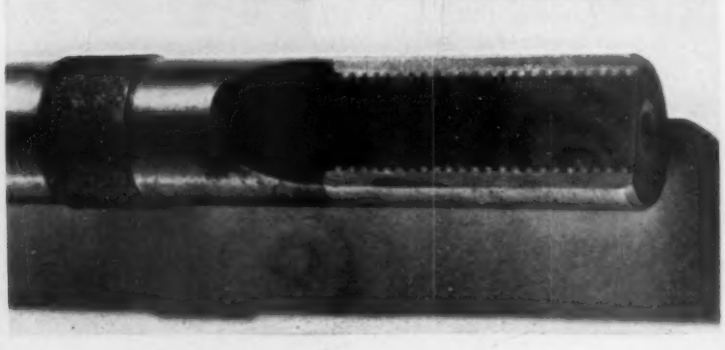
Probably the most widely used method for building up worn shafts of all sizes is the metal spraying method. This use represents an especially suitable application for metallizing because of the peculiar, porous structure of sprayed metal coatings.

For some purposes, this porosity is a limitation on the use of sprayed metals because it weakens the tensile strength and toughness of the coating. Consequently, metal spraying cannot strengthen and stiffen a built-up section as welding does. The porous structure of sprayed metals provides one definite advantage, however, when worn shafts are built up by the metallizing method. This advantage is the exceptionally good bearing qualities of sprayed metal coatings. The pores fill up with lubricant, which is exuded over the bearing surface when the shaft is in service. The effect of this oil film in minimizing friction is the reason for

★

Fig. 6 (right)—The surface of the shaft is here being prepared for metallizing. After a rough thread (24 to the inch) has been cut to prepare the surface, the apex of the thread is broken down by the knurling tool (called a shaft preparation tool) shown in the tool holder.

Fig. 7 (below)—Close-up of pump shaft showing how metallized metal adheres to the base metal when the surface has been properly prepared.



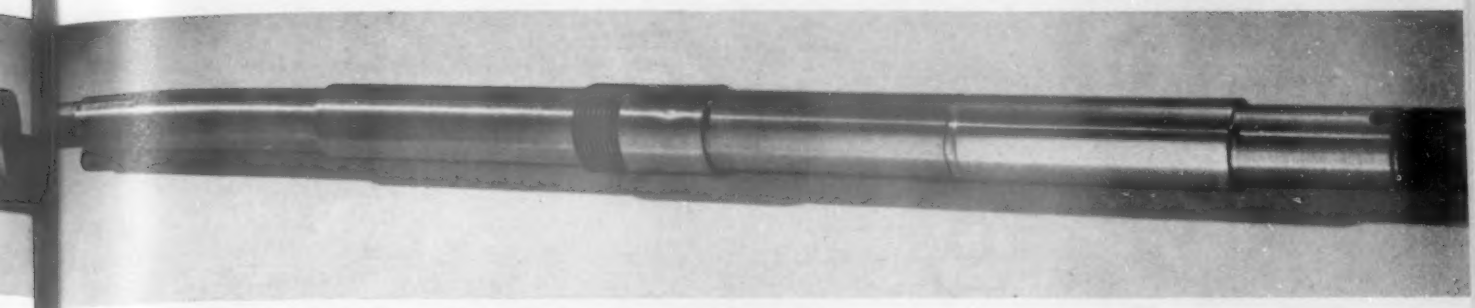


Fig. 5—The finished shaft after being built up by three different methods. Left to right: welding, metallizing and cold casting (electroplating) sections.

the remarkably long service records which have been reported for sprayed metal wearing surfaces.

Preparation for Metallizing

The success of any metalspray application depends upon the securing of a good bond between the base metal and the sprayed metal. Since the sprayed metal particles chill too rapidly to fuse with the base metal, the coating must be keyed or dovetailed into the shaft to provide a mechanical anchorage. This is done, in this instance, in three steps:

First, the worn section is machined to clean the worn surface and provide for the proper thickness of metallized coating. The machining should be done dry, as the metal surface must be kept perfectly clean to produce a good bond.

Second, the machined surface is grooved or cut with a rough thread of approximately 24 to the inch.

Third, the grooved ridges are roughened and spread to form dovetail keys by running a rotary shaft preparing tool across the machined section. This set-up is shown in Fig. 6 with the tool in the tool post.

Applying the Metal

Since any oil, dust, or even fingerprints on the prepared surface can impair the bond, it is advisable to metallize a shaft as quickly as possible after preparation is finished. The first few passes are made with the gun held at an angle to the work, alternately spraying from each side in order to deposit the sprayed Monel underneath the dovetails. The gun is then mounted in the tool post holder with the nozzle six inches from the work, and the balance of the Monel coating is applied at a 90 deg angle to the work.

When metallizing has been finished, the bonded coating is tightly anchored to the shaft by the dovetail keys as shown in the cross-section in Fig. 7, and the tensile strength of the bond is practically equal to the strength of the coating. The built-up sprayed section may be finished to size by grinding or machining and lapping with 00 emery. The finished appearance is shown in Fig. 5.

Electroplating

The third method, one which has attracted considerable attention recently, is the "cold casting" method of building up a heavy coating of electro-deposited nickel. Pump rods and shafts of any size can be reconditioned by this process.

Although electroplating is slower than either welding or metallizing, the "cold casting" method offers three distinct advantages: (1) It eliminates the possibility of heat distortion and warpage of the work. (2) It produces a dense, fine-grained deposit that can withstand any corrosive condition under which solid rolled nickel can be used, and (3) it makes an extremely wear-resistant surface, for the hardness of the plating can be controlled to develop tempers ranging up to several times the hardness of the original pump rod or shaft.

To prepare for cold casting, the worn section of the shaft is machined, and the surrounding area is coated with a "stop-off" lacquer or a special wax. These coatings prevent the nickel from depositing on the masked surfaces where it is not wanted, and confine it to the section which is to be plated. The worn section is then cleaned carefully and etched by an acid treatment to prepare for plating.

The electroplating operation is begun immediately after the etching treatment. The hardness of the deposit is controlled as desired by varying the plating conditions to produce any one of three regular tempers: "soft" from 140 to 160 Vickers, "intermediate hardness" from 230 to 260 Vickers and "hard" from 395 to 500 Vickers or higher. (Vickers hardness values practically correspond to Brinell hardness numbers.) The electroplated section of the pump shaft is shown in Fig. 8.

Finishing to Size

When the worn section has been built up with the desired thickness of nickel, the method of finishing it to final size will depend on the hardness of the plating. If the plating is "hard," it should be finished by grinding. Plating of "soft" or "intermediate hardness" can be readily machined. In machining electroplated nickel, a soluble oil lubricant should be used and machining should begin at the center of the work to facilitate the removal of the natural overgrowth of "berries" which deposit at the ends (see Fig. 8).

* * *

Acknowledgment is made to The International Nickel Co., Inc., for permission to reproduce the photographs which accompany this article.

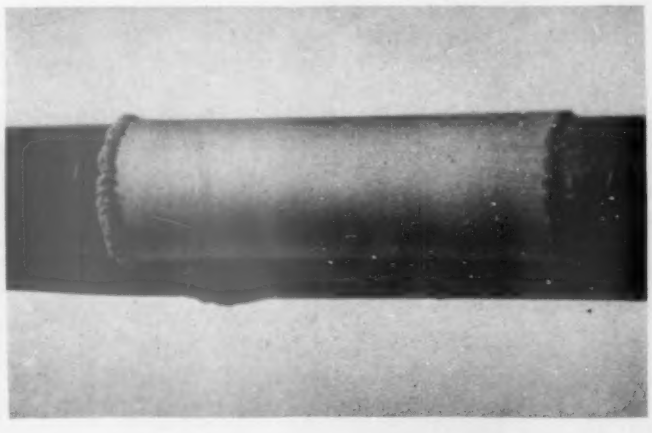


Fig. 8—Close-up of the electroplated section of the shaft. Note the "berries" which deposit at the ends.

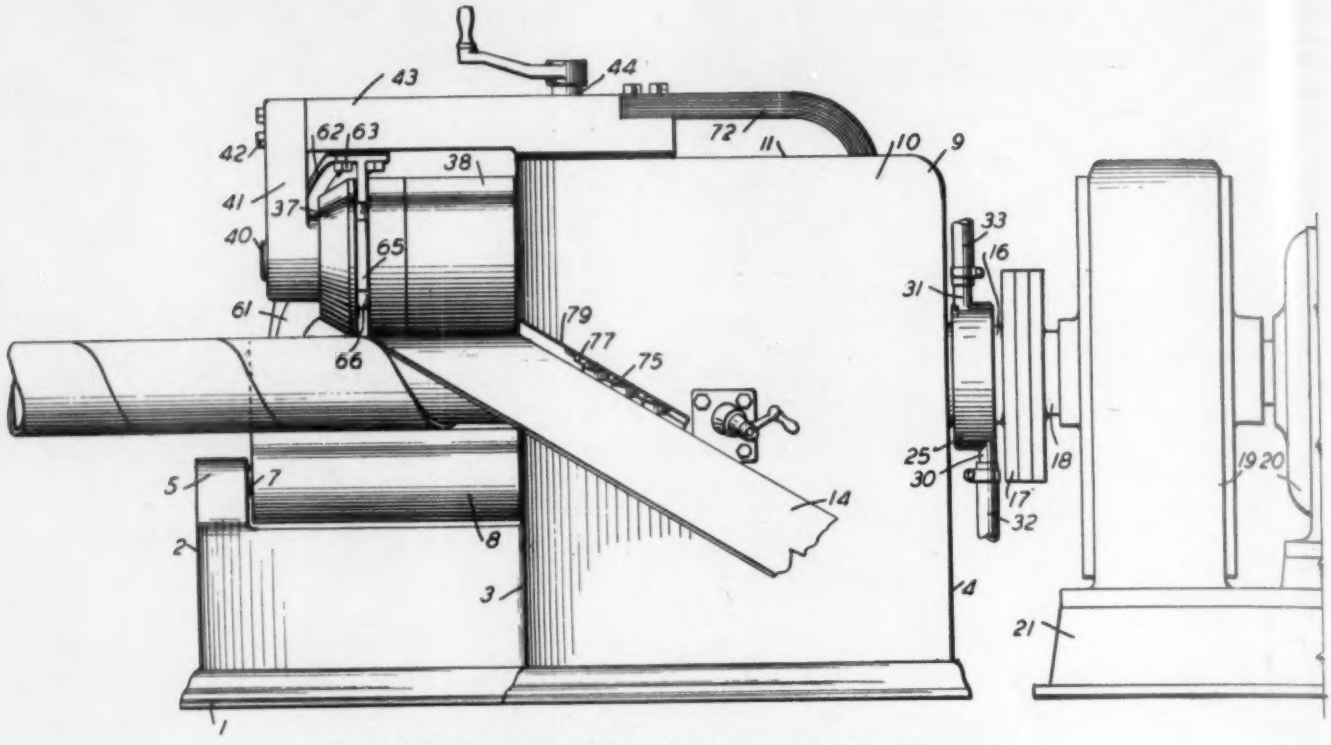


Fig. 1—Original spiral pipe welder making hammered resistance welded joints.

Hammered Resistance Welding

The old technique of the blacksmith shop is applied to resistance welding in order to produce edge welds with low power consumption and without flash or fin. This process combines electric heat with a hammering action.

By A. L. PFEIL*

President, Universal Power Corp.

RECENTLY there has been developed a resistance welding process in which electric current is used to supply heat at the edges to be welded while, as in the blacksmith weld of old, a hammering operation is simultaneously carried on directly at the weld heat point. This development grew out of a machine that was specifically designed to make narrow strip, spirally wound, into fluid-tight welded pipe or culvert of fairly large diameters.

To start at the beginning, a brief review of the basic facts involved will serve to make more understandable the merit of the "hammered resistance" welding process.

In essence in resistance welding, we usually have a single phase power supply voltage fed into a transformer primary winding which supplies the welding energy in the form needed to another, or secondary, winding that is put on the same transformer core to deliver a very high current ranging from 3,000 amp to 100,000 amp at from two to roughly twelve volts—sometimes more.

Spot Welding

The most used and best known resistance welding process is simple spot welding in which a heavy current is put through small points at "unethically" high current densities to confine current flowing into as relatively small an area as possible through the two steel pieces to be welded. It is to be noted that in spot welding the place where we want our heat to be most intense is the small area between the surfaces of the metals to be joined. We therefore use copper alloy points which, in addition to being good electrical conductors, are excellent conductors of heat — many times better than iron or steel. These points, especially when internally cooled by water or refrigerants, stay relatively cool and tend to keep the steel surfaces they contact under pressure relatively cool also, so that as much as possible the heating is confined to creating a molten globule between the surfaces to be welded. After the heating current is cut off (with pressure still sustained), this globule is cooled into a small nugget-like casting, which unites the two pieces. There should be no fireworks in the spot welding process when properly used—the best welds occur under correctly predetermined conditions of current time and (to some degree) pressure and (to a large degree) cleanliness of surfaces to be welded.

*Abstract of paper presented before the Cleveland and Youngstown sections of the Association of Iron and Steel Engineers.

Seam Welding

In conventional seam welding of the overlapped joint type, spot welding technique is followed, using either a series of overlapping spots or sometimes also a continuous and uninterrupted current flow. The latter may be used where the pieces to be welded are moved relative to the roller contacts at speeds suiting the heating current settings.

In butt seam welds, such as in the making of welded steel tube under the several patented processes now available, the usual procedure is to form the tube in such a way that the abutting edges are caused to be pressed into electrical contact at the place where the current feeding rollers are located. This forces fusion to occur under conditions which differ somewhat from the spot weld and lap seam weld because the edges while at a plastic temperature are squeezed up into a pressure forging type of joint. In some such welds, the extra metal pushed up is allowed to form as an outside bead which is later removed by a planing, grinding, cutting or scarfing operation. In other welds, the heated metal is completely combined by rolls or dies so that no flash or excess metal is formed.

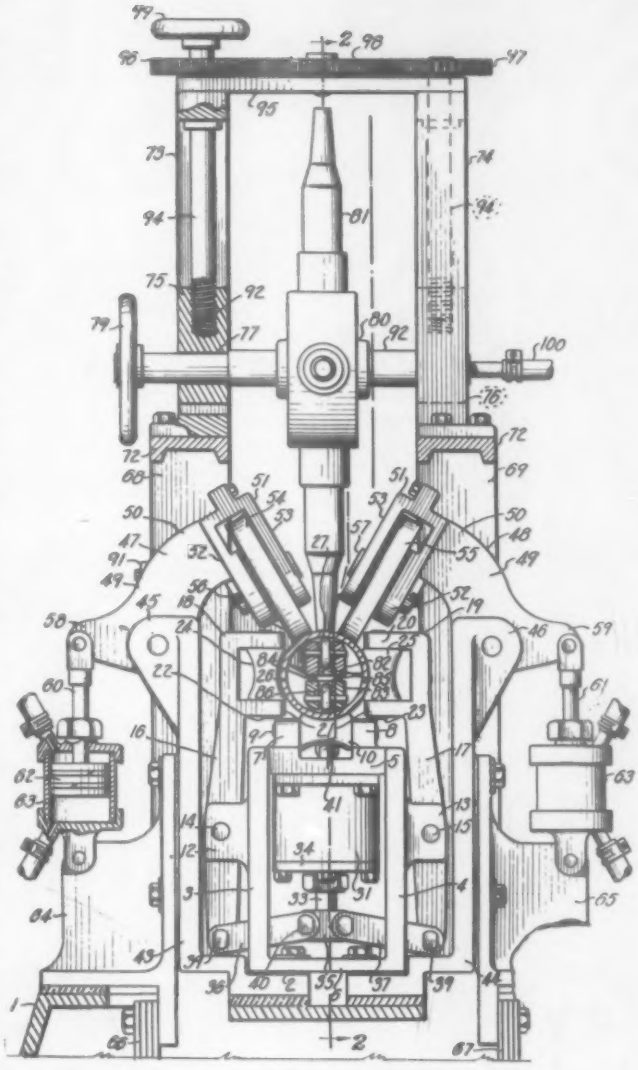


Fig. 2—Tube butt welder making hammered resistance joint.

Flash Welding

In edge welding, that is flash welding of flat or formed sheet or butt welding of bar stock, a somewhat different action occurs than in spot welding. A consecutive series of contact surface arcs—inevitable because of the large areas of abutting pieces—are formed as the edges are brought against each other. The heat so generated makes the contacting edges plastic or molten, after which the edges are pushed together and the burned metal squeezed out into a flash or fin to permit the molten metal back of the edges to be formed into a good joint. The flash is then knifed or ground off, leaving the joint of about the same thickness as the original plate.

This flash welding operation is that used on the strip mill welders with which most steel men are familiar—where one hot rolled steel strip end is joined to the one following it to keep a continuous piece going through the pickling tanks prior to other finishing or cold rolling operations.

The New Process

The hammered resistance weld is a combination of the tube butt weld and edge flash weld procedure above outlined except that no flash or fin is created and no fireworks take place because the welds are of a progressing, continuous time type.

Originally, the process was conceived to make spiral wound, large diameter steel pipe with relatively thin walls from narrow strip. The same idea was later tried on straight seam welded formed steel tubing and, more recently, for butt welding flat strips edge to edge to simulate the requirements of a strip mill welder.

In simplest terms, the welder consists of: (1) a pair of current feeding rollers or shoes in contact with the top surface of the two pieces to be joined and (2) an air or electrically-operated hammer between these rolls and above the edges to be joined. The purpose of the hammer is to bring the edges together and to create a rapid forging action on the joint as it is heated and fused together and during the postweld cooling cycle if desired. In other words, it is simply the old blacksmith's weld made with edge contact electric resistance heating means.

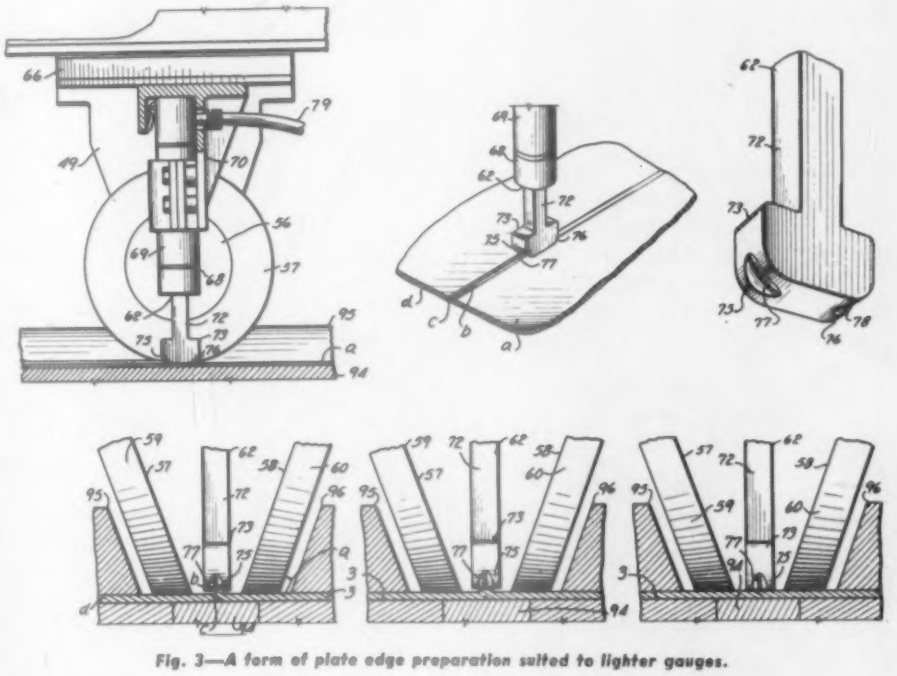


Fig. 3—A form of plate edge preparation suited to lighter gauges.

Fig. 4—Dished steel plate showing ductility of the welded joint.

Advantages

The advantages of this process appear impressive when the new method of joining edges is compared to the flash weld process. Some of the advantages are:

(1) The electrical kva input or demand required is about one-fifth that required for flash welding to do the same job in the same time.

(2) The cost and mass of the apparatus is conservatively about one-third that of flash weld apparatus to do the work.

(3) The weld metal joint produced is at least equal to that of the flash weld and may be controlled as to finished thickness and hot or cold forging action.

(4) No metal is heated that has to be cut off and thrown away; *i.e.*, no flash or fin. Thus the need for an extra operation is eliminated.

In these days when power demand charges and surges should be kept at a minimum to avoid overloading utility systems, the hammered resistance welding process has much to offer.

The mass of the apparatus and its cost may be considerably less than conventional welded tube mechanisms since the intermittent impact action of the hammer blows attains the same effect as is attained with the heavy, continuous high pressure rolls. No data are yet available as to comparative power consumption of the conventional tube butt weld as against the hammered weld; it is felt, however, that because of the intermittent hammer blows, the edge contact resistance is higher at the weld and consequently lower current is called for in order to produce the needed heat.

In the hammered resistance weld, properly controlled, the metal shows no sparking during the actual welding while the hammering is joining the sheets. The heated metal, immediately following the hammer, has a dull, dark red color.

Tensile Strength and Hardness

Typical pull tests on uniform section coupons welded by this method showed that mild steel of 50,500 psi tensile strength broke outside the weld zone at 50,600 to 51,200 psi.

Hardness tests show the as-welded metal in the weld zone harder than the original plate where no annealing rolls are used. For example, the plate showed a Rockwell B hardness of 45 while the welded zone itself showed 65 Rockwell B. At the roller contact points, where the current entered the plate and where roll pressure exerted a cold working effect, the unwelded plate showed a hardness of 68. This weld zone hardness can be controlled by after-heating rolls or other annealing means if desired.

As to the metal structure in the fusion zone, metallurgically, the steel became molten or approached the melting point to permit actual welding of the separate pieces of steel strip. The weld microstructure shows a tendency towards the Widmanstatten type commonly associated with cast structures.

Fig. 5—Microphoto of weld joint of 18 gauge plate welded by the hammered resistance process.

Fig. 6—Microphoto of the fusion zone at 250 diam magnification.

Induction Heating—a New Tool

One of War's important new tools for joining metals is the method of brazing on a production basis by means of induction heating. High frequency currents are used to produce a fast, localized heat that is capable of being closely controlled to any predetermined temperatures.

By J. WESLEY CABLE

**Development Engineer,
Induction Heating Corp.**

THE PRACTICE of joining metals by high and low temperature solders, long accepted as a standard procedure, has been greatly increased by the wartime burden placed upon existing forging and casting facilities. Production line brazing, however, requires fast, accurately controlled heat that may be restricted to the joint area. Using flame and furnace heating methods, it is difficult, if not impossible, in the majority of cases, to satisfy these conditions. An open flame is often hard to control; furnace heating cannot be confined to limited areas. There was need for a new heat source that would combine localized heating with an accurate time and temperature control.

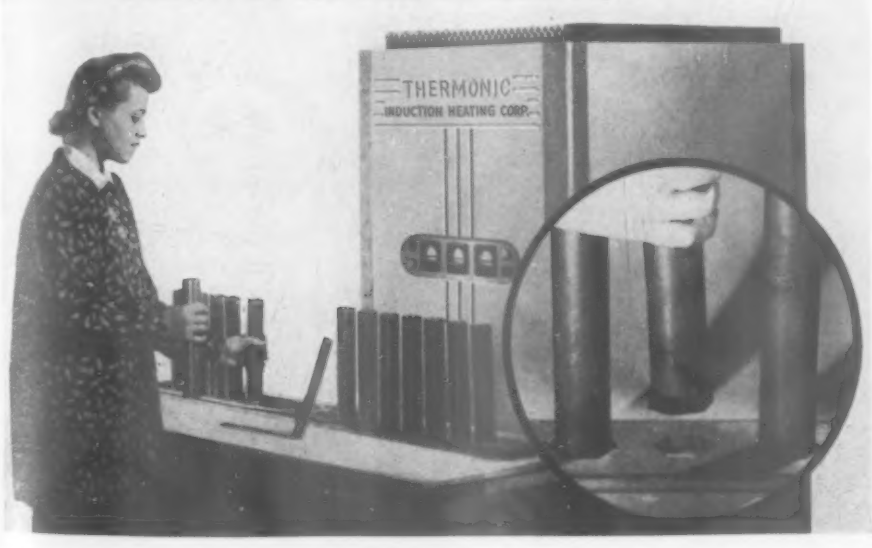
The introduction of induction heating to the metal-joining field tends, somewhat, to solve this problem for industry. Induction heating will produce a fast, localized heat that is capable of being controlled within close limitations to any predetermined temperature. Moreover, induction heating is readily adaptable to mass production. Installations now operating in production lines consistently produce joints of the highest quality at rates of speed greatly exceeding any heretofore attainable.

Fundamentals

Induction heating may be defined as the raising of the temperature of a material by means of the electrical generation of heat within that material and not by any other method such as convection, conduction or radiation. It is essential that the material being heated shall not be part of any closed electrical circuit supplied from a source of electrical energy as is the case with resistance heating.

Induction heating is a phenomenon caused by an alternating magnetic field. Such a field occurs in the area surrounding a conductor carrying an alternating current, and the reversals of the magnetic field follow the reversals of current in the conductor. Magnetic material, if placed within this type of field, is heated by both hysteresis and eddy current losses. Hysteresis loss is caused by molecular friction within the material, and the magnitude of this loss is directly proportional to the frequency of the magnetic field. Eddy current losses are resistance losses resulting from small circulating currents within the material. This loss is proportional to the square of the frequency and the square of the current flowing in the field-producing conductor.

Brazing set-up for 4 lb incendiary bombs. The problem was to braze a solid hexagonal cap to a steel tube. A ring of brazing alloy was placed in a groove in the base so that it would flow, when heated, to form a gas-tight joint.



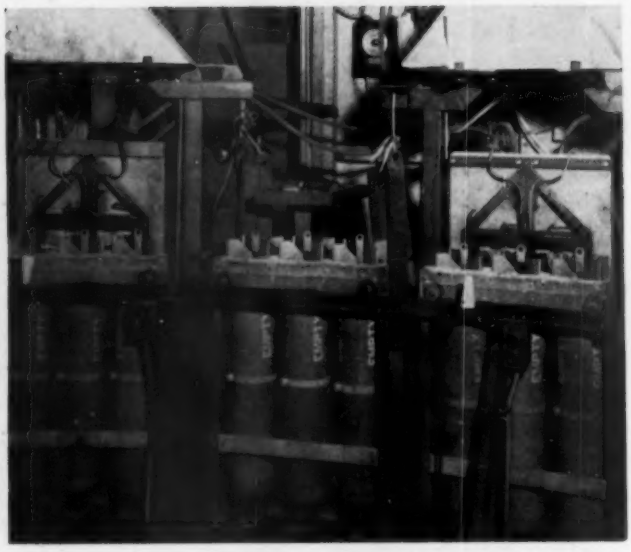
High Frequencies Necessary

Brazing by induction heating is accomplished by placing the joint to be brazed in an alternating magnetic field. This type of heating is applicable to either magnetic or non-magnetic materials. The heating of non-magnetic material depends solely upon eddy current losses. Since the resistance of non-ferrous (non-magnetic) metals is usually less than that of ferrous metals, this loss is comparatively small, and hence a stronger magnetic field must be used to obtain comparable heating results. Eddy current losses are a function of the frequency of reversal of the magnetic field, and the frequency of the field is determined by the frequency of the current flowing in the conductor. It is necessary, therefore, to go to high frequencies in order to secure an appreciable heating effect.

There are three available sources of electrical energy at frequencies (and with capacities) suitable for commercial induction heating: the rotating electrical generator, the resonant spark-gap circuit and the vacuum tube oscillator. These sources cover a frequency range from 1,000 cycles to 5 megacycles. Each method has its inherent advantages and disadvantages.

The Generator Method

The rotating electrical generator has the distinct advantage of being available at capacities up to 250 kw output. Consequently, large en-



Coils and assembly for brazing flanges onto 30 lb incendiary bombs. The flange and a prefabricated ring of brazing wire are pressed into position by hand while the sheet steel bomb containers ride the production line on a traveling carriage. The induction heating coils are energized by pressing a button. A pilot light signals the operator when braze has been completed, and heat shuts off automatically.

Courtesy, Handy & Harman

ergy requirements can be met. One disadvantage of this method, however, is that its frequency range is limited by mechanical design to a maximum of approximately 15 kilocycles. Even though the equipment can be made in large capacity units, the available energy for producing a magnetic field is limited by the comparatively low frequency.

The rotating generator method also carries with it the maintenance problems of high speed rotating machinery and presents a low overall efficiency due to friction and winding losses. Because of the low frequency, inductive loads placed across the terminals of the generator have a comparatively low impedance, and, therefore, do not require high terminal voltages. The cooling system employed with this type of generator is usually forced air, circulated by a fan attached to the shaft of the motor-generator set.

The Spark-Gap Circuit

The resonant spark-gap circuit for producing high frequency consists fundamentally of a step-up transformer converting standard frequency low voltage energy into energy at a potential of the order of 3,000 volts. Across the terminals of the step-up transformer is a circuit consisting of a spark-gap capacitance and inductance; the ratio of capacitance to inductance, along with the spark-gap characteristics, determines the frequency at which the current flows in the closed circuit. The output of this type of generator is usually taken from a second inductance coil magnetically linked with the main inductance of the circuit.

The physical size of the inductance and capacitance making up the constants of this circuit set the frequency limits between 80 and 200 kilocycles. These same quantities also limit the output capacity of these generators to approximately 20 kw. As the higher frequencies are approached, more critical matching of the output load is required; to accomplish this result, the coupling between the primary and the secondary inductances is usually variable.

Units of this type have the advantage of being static and fundamentally simple in construction. They have limited output, however, and the maintenance of the spark-gap for uniform frequency control is considered by most users as a distinct disadvantage. Various types of spark-gaps are used: some are air gaps while others operate in an inert atmosphere, but, regardless of these differences, periodic reconditioning is essential.

The Electronic Tube Method

The third method of producing high frequency electrical energy is the vacuum tube oscillator, which depends upon the characteristics of electronic tubes in producing rapid electric pulsations. This equipment also consists of a capacitance and inductance; the output frequency depends only upon the ratio of the value of these two constants. The usual method is to employ three-element vacuum tubes as oscillators which are fed through a bank of mercury-vapor rectifiers. The fundamental circuit takes low voltage alternating current and steps it up to approximately 10,000 volts; this voltage is in turn rectified into a full wave D-C potential, which is used to charge a capacitance through the oscillator tube circuit. The discharge current from the condenser passes through the inductive shunt circuit, in series with which are the output terminals of the generator.

Frequencies ranging from 200 kilocycles to 5 megacycles may be obtained with oscillators of this type, depending upon the electronic tubes employed and the circuit constants. These units are entirely static in operation and are fixed frequency generators. Their physical size is relatively small per kw capacity, and the input power factor is practically unity. The vacuum tubes have shown their ability in radio broadcasting to give service for 10,000 to 15,000 hours. The disadvantage is that the tubes require water cooling. This difficulty, however, is relieved somewhat by the fact that the high frequency leads and coils in practically all types of induction heating equipment necessitate water cooling, and the water used for this purpose can also be used to cool the tubes.

Producing the Magnetic Field

After obtaining a source of high frequency electrical energy by any of the above-mentioned methods, the next problem is the design of a conductor set-up which will give the proper heat producing magnetic field. As stated previously, magnetic fields occur in the area surrounding a current-carrying conductor, and the strength of the field varies inversely as the square of the distance from the current-carrying conductor. Since the primary purpose of using induction heating is to localize heat to a certain specified section, we must produce a magnetic field meeting these requirements and having sufficient field strength to give the desired heating effect.

The usual form of these conductors is a coil, which may be either single or multi-turn, depending upon the flux pattern requirements. Because field strength depends upon the current in a single conductor, its magnitude is amplified by the use of a multi-turn coil, since each turn acts individually as a conductor.

Single Turn Coil

To achieve the optimum result, the above principles must be kept in mind when the coils are designed. A single turn coil is required, generally speaking, when a narrow localized heat pattern is necessary to accomplish the desired brazing results. This type of coil produces a highly concentrated magnetic field and confines the heat producing losses in the material to the desired area. Since the single turn coil has inherently low impedance, it is usually possible to use a number of them in series to heat a number of pieces simultaneously. These coils

have the added advantages of being simply rigged and, by virtue of being composed of only one turn, of lending themselves readily to jigs and fixtures.

Multiple Turn Coil

The multiple turn coil is usually used when a large area is to be heated. It is also utilized for joining various parts to heavy castings, forgings, or any joint that consists of a heavy mass of material where conduction and radiation losses are appreciable. Coils of this design can be made to heat one or more units simultaneously but, as a rule, cannot be made to accommodate as great a number of units as the single turn inductors.

Both types of coils can be designed to fit the contour of the work. Thus the surface of a casting so complex as to be inaccessible to ordinary methods of localized heating can be quite easily heated by induction with a properly designed coil. Coils can also be designed to heat hollow sections internally as well as externally.

The brazing of a hexagonal cap on a 4 lb incendiary bomb provides an excellent example of a multiple brazing operation using a single turn coil requiring a localized heat pattern. Skilled labor is not necessary, and 10,000 units a day are now being brazed by this method. The temperature is controlled exactly to the brazed area, with no annealing and no metallurgical changes beyond that area. The heating cost is only 1/10 of a cent per braze.

In order that the reader may better understand the practical applications of the principles set forth above, the following production line procedures are given, along with the method of approach to each solution:

The 4 lb Incendiary Bomb

The Problem: To braze a solid hexagonal cap to a steel tube without annealing the tube above the joint, and so maintain its previously established physical characteristics.

Solution: As previously stated, a single turn coil is best adapted where localized heating is desired. Localized heat is mandatory in this case since the tubing, if heated above the joint, would expand away from the heavy base section and prevent a good braze from being obtained. Heating of the tube would also anneal the steel and destroy its original physical characteristics. Consequently, it was decided to throw the heat into the heavy base and let the tube heat by conduction. A ring of brazing alloy was preplaced in a groove in the base beneath the tube area and, upon melting, allowed to flow to form a gas-tight joint.

In order to obtain the desired heat pattern, a single-turn inductor type coil was used. Through experimentation, it was found that a one minute heating time gave the optimum brazed joint. It was also determined experimentally that a high-frequency generator of 20 kw output capacity would in one minute heat seven of these units simultaneously to brazing temperature. Consequently, a seven-place inductor type coil was decided upon for the production line installation. In order to get the maximum output, two complete inductors were used with a transfer switch permitting one coil to be emptied and reloaded while the other coil is energized.

Aircraft Detector Tripod

The Problem: To braze tubular struts into bosses in a casting. The final structure was to be closed, precluding the use of continuous coils in induction heating.

Solution: Here, again, the problem was to heat the heavy bossed section and allow the inserted tubing to heat by conduction. The brazing alloy was placed as a ring around the tubing above the boss; upon coming up to temperature, it flowed down into the joint. The unique point in the development of equipment for this work was the split-coil designs necessary to accommodate the work. Solid single-turn inductors were split at a section which allowed the simplest loading and unloading operation, and a clamping device was developed which would permit the coils to be closed and opened as desired.

Aluminum Brazing

The Problem: To braze aluminum tubular sections into an aluminum manifold.

Solution: Here the problem consisted of raising the temperature of the heavy aluminum manifold to 1,070 F, the melting temperature of the alloy, without exceeding the melting point of aluminum. This was accomplished by placing multi-turn coils at a distance of approximately ⅜ in. from the work. Thus fine temperature control was permitted at a forfeit of rapid heating.

●

Like Heat from the Sun

THERE are many brazing and soldering operations now performed by other methods which can be done faster and better by electronic induction heat. The nature of this heat, however, is not commonly understood. It can best be explained by likening it to the radiant heat from the sun. The sun's rays pass through space with little loss, yet when they strike a dark body the surface is heated. In like manner, the high-frequency pulsating magnetic waves, radiated from the induction heater coil, pass through all insulating materials with little loss, yet create heat when they strike any metallic body. The intervening material is not affected.

High frequency induction heat has taken the place of gas heat in the soldering of crystal units for war radio equipment manufactured by the General Electric Co. A two-turn inductor coil is used with a perforated ring nozzle for air blast cooling. The entire heating and cooling sequence is automatically timed to insure uniform seals.

Why the Schenectady Sank

A recent report of the American Bureau of Shipping outlines the probable causes for failure of the *S. S. Schenectady*. This report, though conclusive, is too vague to be considered enlightening to all interested.

SINCE January 16, the air on the West Coast has been filled with speculation, particularly in the vicinity of shipyards, as to why the welded tanker *S. S. Schenectady* should, for no apparent reason, break open and sink. During this period of speculation many theories as to the probable cause have been advanced. Even while the guessing was going on, however, the *Schenectady* was cut in two, towed to dry dock, fitted together, *welded* and refloated.

Description of Failure

The *S. S. Schenectady* was the first tanker built in the new yard of the Kaiser Co. at Swan Island, Portland, Ore. The ship, which was of the Sun Ship design, was 503 ft long, 68 ft beam by 39 ft 3 in. It is believed that no less than 23 tankers of similar design were built during the past year. None of these disclosed any structural defects in service. Nevertheless, while the Schenectady was lying afloat in the fitting dock of the Swan Island Yard on January 16, 1943, she broke in two with a loud report. A fracture suddenly appeared across the deck at a point just aft the after end of the bridge about amidships. This fracture extended down the sides to the bottom shell plating, which remained intact. All deck, side and bottom longitudinal frames fractured as did also the plating of the corrugated longitudinal bulkheads and the centerline deck and bottom girders. The structural failure was complete except for the flat portion of the bottom shell plates. In no case did the fracture occur in a transverse weld.

The ship jackknifed so that the bottom shell plate knuckled transversely and showed above the water while the forward and aft sections settled in the silt so that the deck was opened about 10 feet. From the character of the fracture of the side shell, it appears that it was formed gradually and progressively as a result of tearing rather than by sudden fracturing, as was evidenced in the deck from gunwale to gunwale.

Probable Causes

It is only natural that many theories should be advanced as to the cause of such a failure. The probable causes advanced by theorists include practically every reason under the sun, but those receiving most votes are: poor steel, poor welding, improper welding sequence, shrinkage stresses, prefabrication, improper loading, the difference between air and water temperature, earthquakes, silt and a side wind.

In what might appear to be an effort to keep everyone happy, the American Bureau of Shipping in its "Report of the Findings of the Special Sub-Committee Appointed by the American Bureau of Shipping to Investigate the Structural Failure of the Tanker *S. S. Schenectady*" agreed that most of the reasons advanced contributed to the failure.

The opinion of the committee of outstanding engineers selected by ABS summarized the failure of the tanker *Schenectady* as a combination of unfavorable circumstances. The principle cause was an accumulation of an abnormal amount of internal stress locked in the structure by the processes used in construction. To this was added an acute concentration of stress caused by defective welding in the starboard gunwale at the abrupt ending of the bridge fashion plate. Augmented by the hogging stress due to the ballasted condition, this accumulation and concentration of stress caused a tensile failure at the starboard sheer strake, which was formed of steel of sub-standard quality. All of these conditions are believed to have been aggravated to some degree by a drop in the atmospheric temperature.

Bad Steel

In a failure of this type someone usually gets hurt, and there may also be some "buck passing." Conse-

One need not look for evidence of the important job that welders are doing in our vast war program. Without guns and with helmets not seen on battlefields, thousands of shipbuilders like these are nevertheless fighting the Axis with relentless and heroic effort. Their fighting tools are arc welders and welding electrodes, and they are battling against time to make America's two-ocean Navy a reality and to keep Liberty ships coming off the ways on schedule.

Courtesy, Harnischfeger Corp.

quently, everyone may not agree with the above findings. To cite one instance, Henry J. Kaiser probably does not wholly agree with the ABS. Kaiser had previously contended that defective steel was the main cause. In support of this view are recent disclosures before a Congressional investigation committe indicating that some steel companies are not wholly without sin under the pressure of war work.

As indicated above, defective steel did play a part in the crack-up. There was an apparent lack of uniformity in the quality of steel used in the whole structure. For example, when compared with other plates, the particular sheer strake plate on the starboard side, where the fracture apparently started, had a very low proportional limit (10,000 psi), as was determined by stress-strain curves. The impact values from this plate were also low, even at room temperatures, and brittle at 20 F. The values of the notch bend test also indicated considerable brittleness. It should be recognized, however, that impact and notch bend tests are not included among the ordinary commercial tests by which the quality of structural steel is determined.

About the first repercussion of the sinking was the issuance of new rules by ABS which ban the use of submerged melt welding as a means of joining deck plates to side plating where it is necessary to lay a heavy bead of metal. Submerged melt welding of the automatic type has been used for years in the building of this type of tanker and has always been considered practicable as well as popular with the shipbuilder. Though this new ruling must be met, the submerged melt process will still be used extensively elsewhere in the construction of ships.

Welding Difficulties

The accumulation of the shrinkage stresses which occurred in the submerged melt welding of the deck assembly joints (especially in the longitudinal joint at the gunwale) attaching the sheer strake to the stringer plate appeared to be serious. This particular weld was also found defective in the vicinity of the location where the failure started. This was evidenced not only by a longitudinal crack but also by what appeared to be minute transverse cracks in the weld.

The report also indicated that there might be a tendency on the part of shipyard workers to depart from the recognized fundamentals of good welded construction. This cannot be condoned, even for the laudable purpose of speeding up construction to the utmost possible extent to meet the needs of the present emergency. There were also indications of neglect on the part of the personnel to realize the importance of rigidly adhering to established procedures and to the welding sequences which are necessary to reduce shrinkage stresses to a safe minimum.

It was suggested that, owing to the rate at which production was maintained, there was probably an insufficient number of trained, experienced weldors and shipfitters available for this job. Also, there was an indication that there was an inadequate number of skilled welding supervisors with the necessary knowledge of the basic elements of good welding practice to exercise proper control over the weldors.

While prefabrication is an excellent means of speeding up ship production, the investigations brought about as a result of the *Schenectady* failure indicated that there was evidence (in the sister ships under construction) of poor fitting of large assemblies. This poor fit-up necessitated considerable forcing into position by excessive use of jacks, turnbuckles, etc. In other instances, there were found open joints which required the use of an excessive amount of weld metal. Because of the large amount of welding needed to finish joints of this type, excessive shrinkage was experienced.

Loading Conditions

At the time the *Schenectady* failed, the forepeak tank, the forward deep tanks, and the afterpeak tank were full of water as ballast for the trial trip, and, in addition, there were about 3,100 bbl of fuel oil in the cross bunkers immediately ahead of the machinery space. This resulted in a bending moment—in hogging in still water—which produced a tensile stress on the upper flanges of the hull girders of approximately 9,000 psi. This stress was about half the maximum designed bending moment and certainly was not sufficient in itself to cause any failure in the structure.

"Can you lend me a cup of Thermit? Just a little to finish a batch of incendiaries!"

The low temperature must also be mentioned. Before the day was over, January 16th proved to be the coldest day in Oregon's history, according to one authority. From a high of 38 F, reached at 2:30 P.M., the temperature dropped to 23 F at 11:00 P.M., the time of the failure. The river water temperature at that time was about 40 F. A drop in air temperature of 15 F over a period of 8½ hrs, while not an extremely sudden temperature change, probably would suffice to introduce the factor of increased brittleness of steel at temperatures below freezing.

As for the other causes advanced regarding the sinking of the *Schenectady*, apparently there is little ground to stand on. Seismograph records indicate that there were no earthquakes on January 16. An examination of the vessel in dry dock disclosed no indications of grounding damages which might have been present had the ship been left high and dry, so to speak, to break on a sand bar. Side winds could hardly have had any effect upon a ship of this type, which takes a more severe buffeting from the waves than could ever be imposed by winds while at dock.

Conclusions

Immediate conclusions reached by the committee include the following:

"The procedure immediately recommended and carried out whereby the defective welding previously referred to was removed from the *S. S. Schenectady* and sister vessels and these joints properly rewelded has proven a satisfactory corrective measure as demonstrated by the application of severe bending tests (hogging and sagging). It is the opinion of the Committee that the high stresses responsible for the fractures that have recently occurred in welded vessels were due primarly to the failure to adhere rigidly to the procedure necessary to keep shrinkage stresses within the margin of strength allowed in the design. Steps have been taken with the full coöperation of all yards concerned to insure adherence to proper established procedure, and the managements of the yards are fully alive to their responsibilities in the matter. The Committee feels that closer control of welding procedure, in which the builders have already been instructed, will prevent a recurrence of such major failures. It is also the opinion of the Committee that the probability of fractures resulting from residual stresses in welded construction will decrease with the length of service."

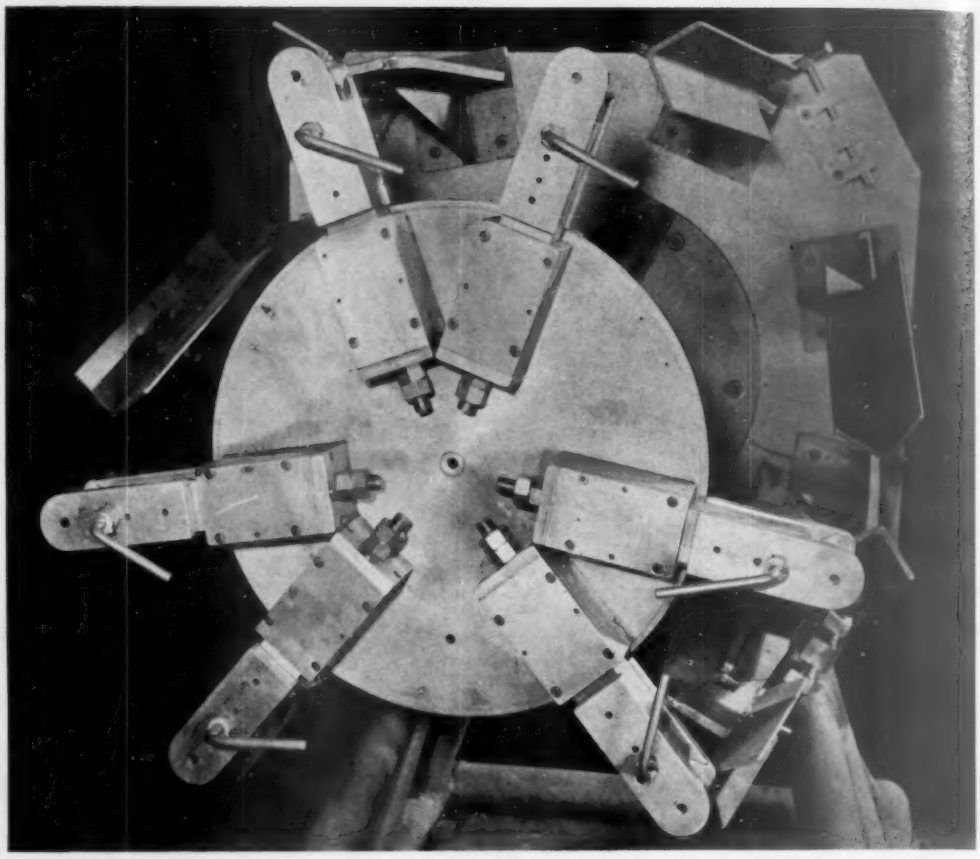


Fig. 1—The main assembly jig for a motor mount. The parts located in this jig are preheated for welding.

Applying Welding to Aircraft

Arc, gas or resistance welding each has its particular field of usefulness in aircraft fabrication. Design of jigs and fixtures, establishment of procedures, weldor qualification tests, testing and inspection techniques —all are needed for the making of better war planes.

By **FRANCIS H. STEVENSON***

Assistant Superintendent, No. 2 Plant, Vega Aircraft Corp.

IN THE aircraft industry today there are in use two main welding processes: resistance and fusion. The fusion process is divided into two types, gas and arc.

Let us look into the gas welding first. This includes oxy-acetylene and oxy-hydrogen; the hydrogen is used mainly in the welding of aluminum parts such as oil tanks, and the oxy-acetylene process is used on all small fittings such as pulley brackets, etc.

Oxy-Acetylene Welding

Thorough fusion between the base metal and the metal added from the filler rod is necessary throughout the entire weld. Theoretically, a strictly neutral flame is indicated for welding SAE X4130 by the oxy-acetylene process; we have found, however, that much better results are obtained by using a very slight feather on the flame. This slight excess of acetylene has a fluxing action on the surface oxides, yet it does not cause carbon pick-up by the base metal.

Another point to watch is the direction of the welding. To start the weld at the edge of a piece will nine times out of ten cause a crack. It is necessary, therefore, that welds be made toward the edge by starting at some point in from the edge. The fit-up of the parts must be watched very closely, too.

Advantages

Some advantages of the oxy-acetylene process are: (1) low initial cost of equipment; (2) a large variety of materials can be welded; (3) welds can be produced at reasonable cost.

*Abstract of a paper presented Oct. 13 at the annual AWS meeting, Cleveland.

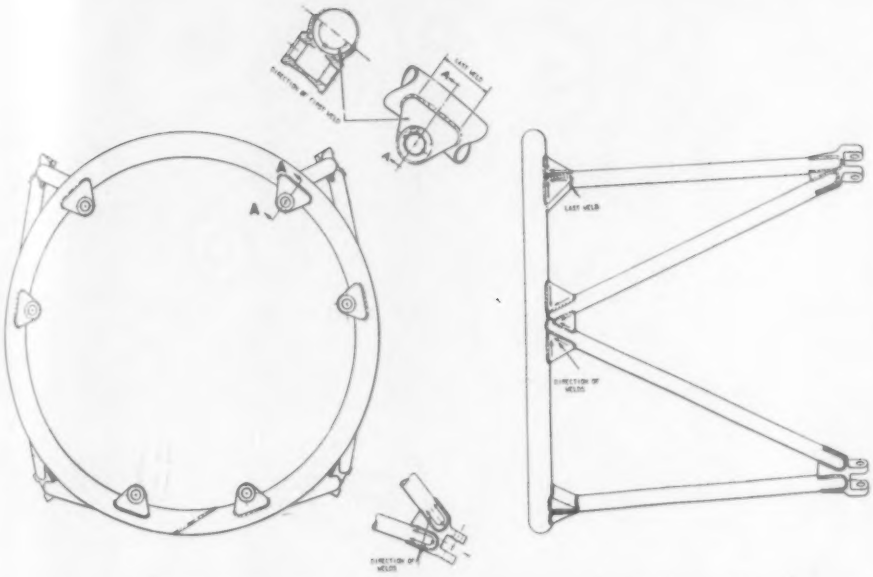


Fig. 2—These sketches show the manner in which gussets are welded to the ring and legs of a motor mount, and the direction of the welds when feet and motor forging are welded onto the ring.

The disadvantages of the oxy-acetylene process are: (1) an excessive amount of expansion and contraction; (2) highly skilled operators are required to produce a good weld; (3) the process is not satisfactory for heavy sections.

Arc Welding

Arc welding has made great strides in the last few years in the aircraft industry, and the manufacturers on the West Coast seem to have pioneered this process to a great extent. Some of the advantages of arc welding are: (1) its ability to produce strong, sound and ductile welds; (2) nearly all varieties of carbon and alloy steels can be welded; (3) it is adaptable to automatic welding; (4) satisfactory welds can be produced in heavy as well as in light sections.

Some of the disadvantages are a relatively high initial cost of welding equipment and the fact that highly skilled operators are required to produce good welds.

Welding a Motor Mount

To gain an idea of the procedure being used, let us go into the shop and watch a motor mount being welded. The main assembly jig is shown in Fig. 1. You will notice the clean lines and accessibility of this jig; these points will be discussed later. After the parts have all been located in the jig, the part to be welded is given a preheat of 250 F to 350 F. The welds are split, opposite tubes being welded in sequence. After all welding is done that is possible in the jig, the mount is taken out and the welding finished outside. Some trouble may occur at this point in the nature of cracks. Most of this can be eliminated, however, by correct fit-up.

Our next step is to fit in the gussets, which are held in place by a small clamp. The mount is then bolted by its feet onto a frame suspended between two trunnions. This frame can be rotated in any direction, enabling the weldor to sit on a stool and weld in the downhand position at all times. Details of the welding procedure appear in Fig. 2. A mild steel coated electrode of 3/32 in. diam is used. The potential will be 20 to 25 volts across the arc and the current 100 to 120 amp. As in former operations, a preheat of 250 to 350 F, the temperature range previously mentioned, is used.

The welding procedure must be watched very carefully. All of the gussets are first welded to the ring. After one group of gussets has been welded to the ring, then the group directly opposite is next welded. This procedure is followed until all gussets have been welded to the ring. The next step is to weld the gussets to the legs, and the same procedure is used with the addition of the last weld in each group of gussets being made on the back.

The mount is then put back in the main assembly jig for the welding in place of the cowling clips, if used, and for alignment during a stress relief. The temperature used for stress relief is usually 500 to 600 F. The mount is left in the jig to cool, then taken out and checked for trueness. The mount, having been stress relieved in the confines of the jig, has become as nearly perfect as possible for the machining operation which follows.

Fig. 2 also shows the direction of

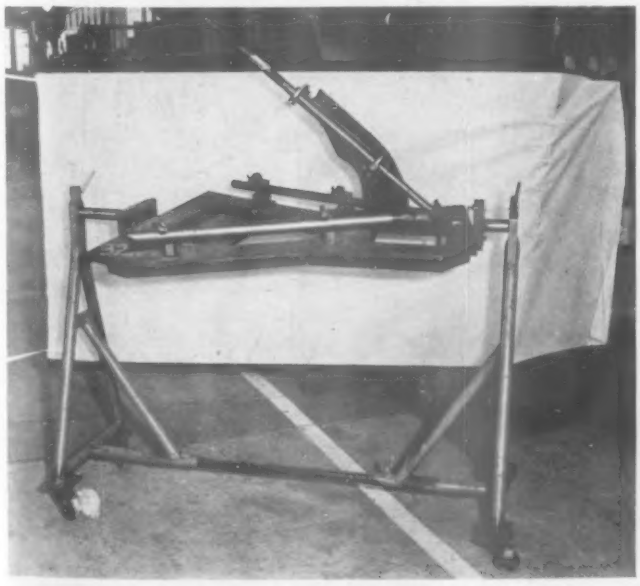
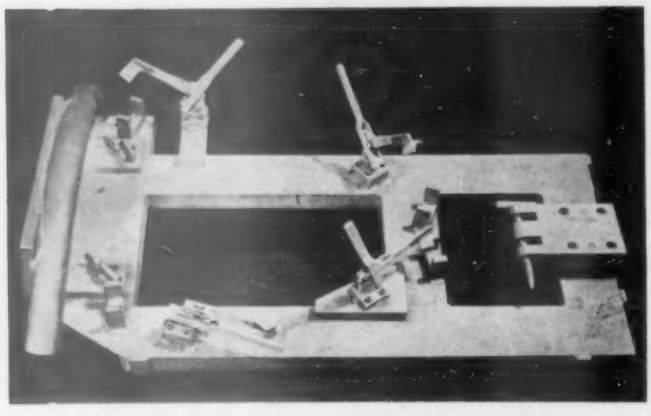


Fig. 3 (left)—Jig used for the welding of motor mount legs to feet. It can be rotated so that most welding will be done in the downhand position.

Fig. 4 (below)—Another jig used for the same purpose as Fig. 3. Note the quick acting clamps which are used instead of thumb screws.



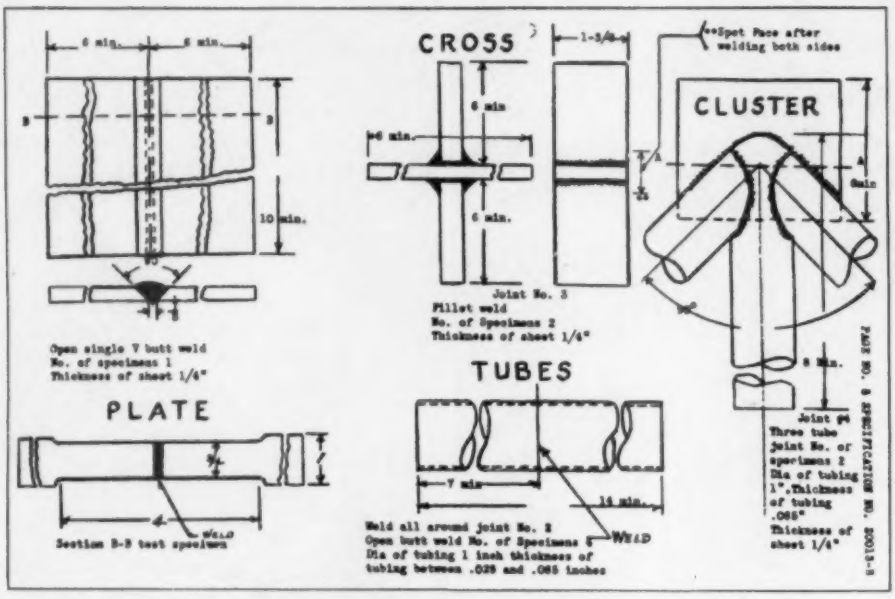

CROSS
CLUSTER
TUBES
PLATE
Open single V butt weld
No. of specimens 1
Thickness of sheet 1/4"
Fillet weld
No. of Specimens 2
Thickness of sheet 1/4"
Joint No. 3
Section B-B test specimen
Weld all around joint No. 2
Open butt weld No. of Specimens 5
Dia of tubing 1 inch thickness of tubing between .028 and .065 inches
Three tube joint No. of specimens 2
Dia of tubing 1". Thickness of tubing .065"
Thickness of sheet 1/4"
WELD

Fig. 5—Details of aircraft welders' qualification tests—plate, cross, cluster and tubes.

the welds when welding feet and motor forging into the ring. Both a preheat and a postheat are used, the heating being done with a hydrogen flame. Hydrogen can be used to very good advantage in both oxy-acetylene and arc welding for preheating, the elimination of scale and for help in controlling the expansion and contraction of very thin sections. While the hydrogen flame actually heats, of course, it seems to have the property of cooling—at least it spreads the heat from the weld so that distortion is not so apt to occur. The simple hydrogen burner can be made of copper tube in various shapes or sizes as needed to fit the work.

Designs—Good and Bad

Apparently, engineers all too often have little fundamental knowledge of welding, and blithely assume that any two pieces of metal, regardless of their shape, size or position, may be easily joined. The writer firmly believes that the shop should be consulted on new designs that call for welding, and he will try to show some designs, good and bad, as they affect the shop and the ease of welding.

The following should be avoided when designing for fusion welding:

1. A joint between very thin and heavy material. The heat required to bring the heavier metal up to the welding temperature may burn or melt away the thin metal.

2. Convergence of more than six members to form a welded cluster. The repeated application of heat on the small area where all the members meet weakens the base metal adjacent to the remelted weld metal.

3. A joint which requires welding at the inside junction of two members forming an acute angle or welding in other inaccessible places.

4. Complicated assemblies of many small parts. It is better to simplify and combine parts.

5. Placing parallel weld beads close together. Either the beads should overlap or a minimum distance of ¼ in. should be kept between their nearest edges.

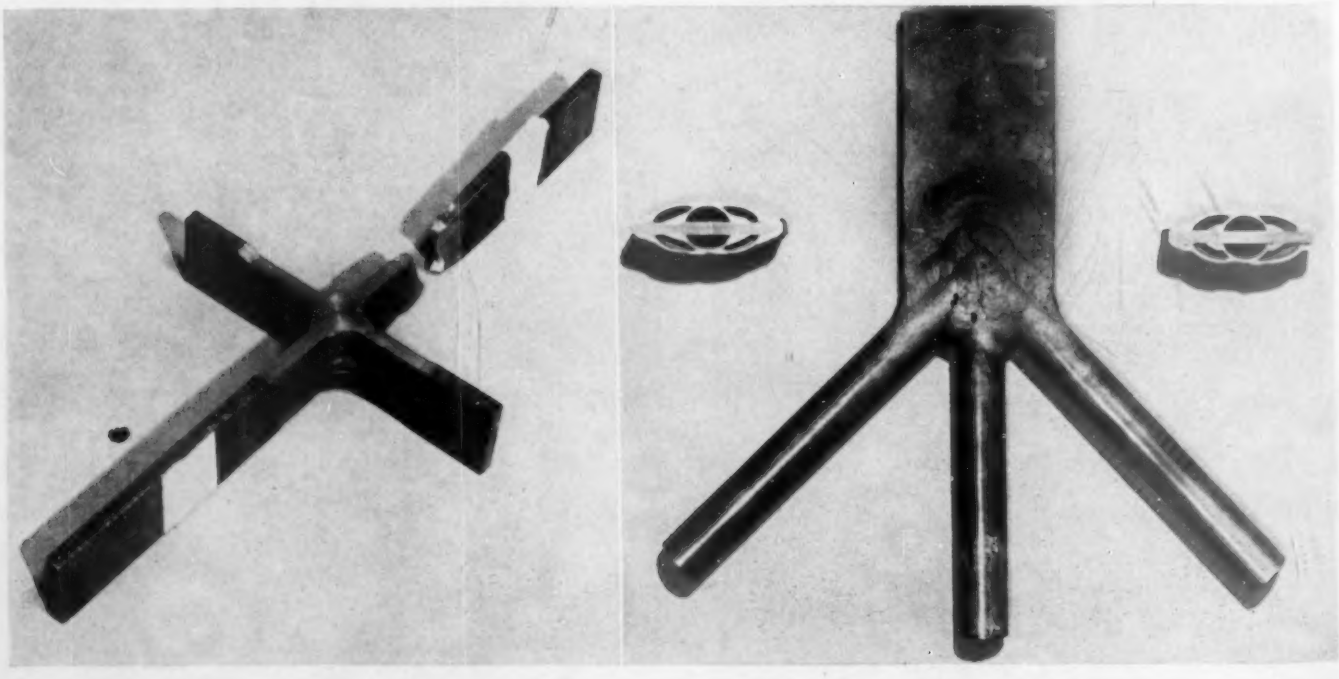
There are other points that could be mentioned, but, on the whole, if the engineer will avoid the above five, we in the shop will be able to give him a better part both from the standpoint of the quality of the weld and the rate of production.

Jigs and Fixtures

The next point to look into is the question of jigs and fixtures. This is where the tool designers and the shop men always come to heated arguments. However, it is absolutely necessary that the welding shop be consulted on the design of all jigs and fixtures to be used by its men. At

Fig. 6—Cross test sample. The specimen must withstand a tensile pull of 15,000 lb per linear inch. Note elongation of the base metal.

Fig. 7—The cluster weld and cut testing specimens. That on the left shows good penetration, that on the right poor penetration.



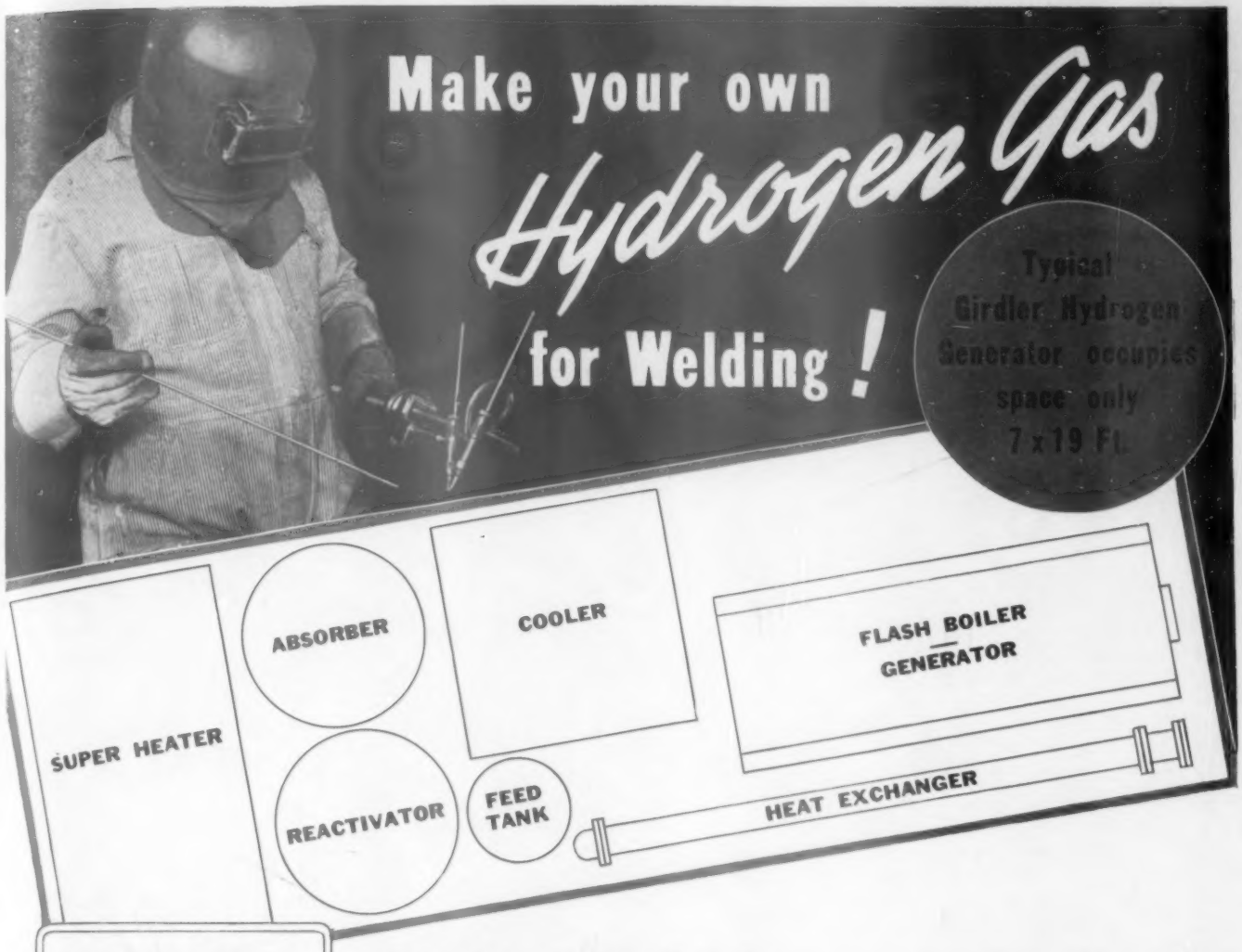


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Fig. 8—A motor mount that was especially designed for arc welding.

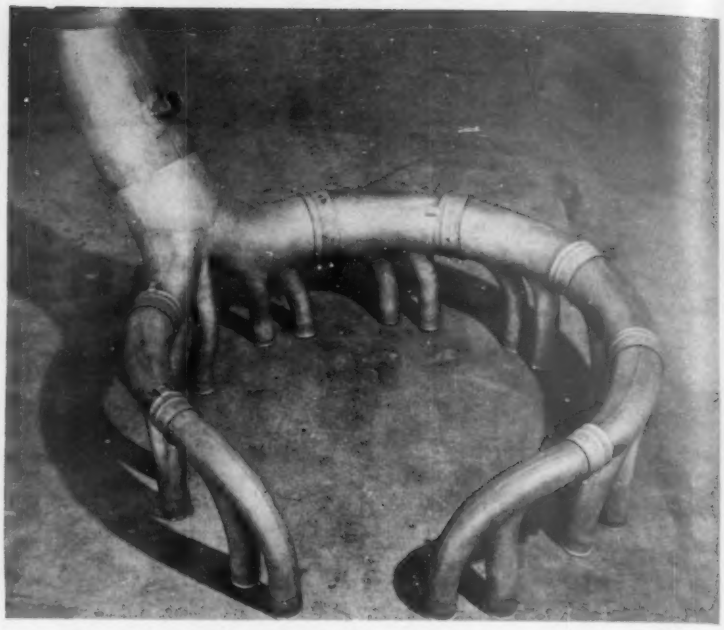

Fig. 9—An exhaust collector ring designed for both oxy-acetylene and arc welding.

Vega, the shop men are always consulted on the design of a welding jig by the tool designers.

Jig design for the fusion welding of aircraft parts is no mere matter of a few "C" clamps and pieces of angle iron; it involves a thorough consideration of the following eight factors:

1. A proper allowance for shrinkage. Torch welded parts shrink more than arc welded parts. Stainless steel and aluminum have greater thermal expansion and contraction than low carbon steel.

2. Proper positioning. The work must be held in position to make a good weld. Downhand positioning is preferred, of course.

3. Accessibility and visibility. It is not enough that the weldor be able to get at his work with the welding electrode or torch; he must also be able to see clearly if he is to turn out high quality production. A jig permitting this is shown in Fig. 3. This jig is used for the welding of motor mount legs to the feet. It can be rotated so that most of the welding is done in the downhand position and is also very accessible.

4. Rigidity. The jig must be strong enough to support the part without excessive deflection, yet at the same time it must have sufficient flexibility to permit the normal shrinkage due to welding.

5. Heat control. The jig must carry away part of the welding heat in order to prevent excessive heat flow into the rest of the welded assembly.

6. Protection of work. On aluminum and stainless steel, it is important not to mar the surface. Protective pads must be provided.

7. Convenience. Parts must go into the jig easily, and the welded assembly must be easily and quickly removable.

8. Clamping devices. Screw clamps should be eliminated wherever possible, and quick acting clamps used in their place. The jig shown in Fig. 4 is used for the same purpose as the one shown in Fig. 3. However, you will note that quick acting clamps are used instead of thumb screws. This jig (Fig. 4) is also mounted and can be rotated.

Army and Navy Specs

In the aircraft industry, any manufacturer building for the Army or Navy must have all of his weldors certified. This is done in accordance with Specification 20013-B of the Army Air Force or with the Navy Specification, which is almost identical. In this paper we will discuss the Army Specification, which applies to both arc and gas welding and covers all the materials that are welded in the aircraft industry. The materials are divided into five groups as follows:

Group I. Carbon steels.
Group II. Stainless steels.
Group III. Nickel steels.
Group IV. Aluminum alloys.
Group V. Magnesium alloys.

In the carbon steel group there are four tests; namely, the plate, the tubes, the cross, and the cluster. Details of all of these are shown in Fig. 5.

Group I is also divided into two classes: "A" and "B". The "A" class is required to complete all four tests, the "B" class to complete the first two only. Groups II, III, IV and V carry only an "A" class. A class "A" weldor in Group I can weld any steel part on the airplane; a class "B" man can weld anything but primary and secondary structures. However, a weldor carrying a certificate for a designated group is not eligible to weld alloys in other groups unless he is certified in them also.

Group I Tests

On Joint No. 1, which is the plate, two pieces ¼ by 10 in. are welded together, and three standard tensile specimens are taken. These are then pulled in a tensile machine. With an alloy base metal and a filler rod of 0.06% carbon, the specimen must withstand a tensile stress of 55,000 psi. The break is examined for good metal appearance.

On Joint No. 2, the tubes, four specimens are taken. Two are welded in the horizontal position and two in the vertical position. With an alloy base metal and a filler rod of 0.06% carbon, the specimen must withstand 80,000 psi.

Joint No. 3, the cross, is welded in the vertical position. With alloy base metal and filler rod with 0.06% carbon, the specimen must withstand a tensile pull of 15,000 lb per linear inch. The break is examined for quality of metal.

Figure 6 shows a good sample of the cross test. Note the elongation of base metal.

Joint No. 4, the cluster, is three tubes slotted and welded over a piece

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¼ by 3 by 6 in. This joint is cut and etched and examined for penetration. Fig. 7 provides examples of both good and bad welds. The left hand view shows very good penetration in both tubes and plate. The right hand view shows poor penetration, and is, of course, cause to reject the weldor.

Other Groups

For Groups II, III and IV, the test consists of two butt welded joints in sheets of the chemical composition to be used in production work. One joint is made between two sheets of an equal thickness which represents the thinnest sheet to be welded in production.

The sheets are usually six inches square. They are cut into specimens approximately 1 in. in width. A specimen is bent 180 deg over one sheet thickness so that the outside of the bend lies in the plane of the weld. The excess metal on either side of the sheet may be ground smooth with the base metal before making the bend. The outside of the bend must be on the side on which the weld is laid. It is cause for rejection if the joint cracks or shows indications of lack of bend between the welded metal and the base metal.

The bend tests are not required for Group V alloys.

Procedure Control

For an aircraft company to get the most out of its welding shop, it is necessary to have a well planned procedure control. Briefly, this should consist of the following points:

1. The design for welding.
2. The selection and inspection of materials.
3. The establishment of a procedure which will give the desired results. Under this heading are included both the preparation of material and the welding procedure.
4. The qualification of the welding operator to follow the procedure.
5. Inspection and testing of the completed work.

A number of design points and problems have already been discussed. Fig. 8 shows a motor mount that was designed entirely for arc welding. Note the clean lines of the finished assembly.

Points 2 and 3

Point 2, the selection and inspection of materials, includes base metal, welding rods or electrodes, gases and apparatus. The affidavits of reputable manufacturers are generally acceptable for the first three items. The welding apparatus, including gauges, pipe lines and welding machines, should be inspected periodically.

A great deal of thought and effort should be expended upon Point 3. In a great many shops, the establishment of a procedure which will give the results desired is left up to the head weldor. By doing this, the shop may often get in bad because the part does not come out like the design or does not do the work for which it is intended. It is suggested that all procedures be worked out in a research laboratory in conjunction with the welding foreman. This will give the engineer who designs the part and the man who makes the part an opportunity to get together and iron out the bumps. Also when the part is made in production, it will be able to perform the function for which it was designed.

It is possible that the welding procedure can be marked on the blueprint, and the marking indicate the starting and stopping points of all welds, the direction of welding, and the welding technique. When this is done, all operators should be required to follow that procedure exactly.

Fig. 9 shows an exhaust collector ring designed for the use of both oxy-acetylene and arc welding. This ring can be built only in a welding shop where the designated procedure is strictly followed. This also applies to the motor mount shown in Fig. 8.

The qualification of the welding operator to follow the procedure is a very important item inasmuch as shops not having procedure control will have scale welding, forehand welding, long and short arc, and other pet techniques. The qualifying of operators is helped greatly by the use of the Army and Navy specifications earlier discussed.

Inspection and Testing

Magnaflux inspection is used for the majority of the welds inspected in aircraft. Though the Army requires that all welds be magnafluxed, the writer's own opinion is that the X-ray method is better for examining welds. If you take one out of every ten parts and X-ray it, you will get a high quality of work from your welding shop. Moreover, you have a print (which can be shown to the weldor at any time) on which his weak points are recorded. Since the weldor never knows which part is going to be X-rayed, he must be on his toes at all times.

Flash Welding

Among the new developments coming to the fore in the welding field, flash welding might be mentioned. Some West Coast aircraft companies are at the present time using flash welding in production for such parts as control rods and various small struts. Fig. 10 shows a flash welder in operation.

As to the future of welding in aircraft, it is the opinion of the writer that we will always need weldors because the torch and the electrode are very good tools if used correctly. There is going to remain a definite place for each process, and in our organization we try to use the process which is the most practical, both from the standpoint of the ease with which the part can be fabricated and the cost of finishing.

Fig. 10—A flash welder in operation. Flash welding is now being employed by West Coast aircraft companies for such parts as control rods and small struts.

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Welding is destined to play an increasingly important role in the life of America, in the better world we're fighting for.

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ST. LOUIS • *Branches: New York • Chicago • Detroit Los Angeles • Davenport*

Today, in factories, and repair shops all over America, Emerson-Electric A. C. Arc Welders are making important contributions to the war effort... by stepping up production and for effective "on-the-spot" maintenance work.

Emerson-Electric Portable A. C. Arc Welders are made in four sizes, in six types. Welding range 20-300 amps. Available on priority rating. Write for catalog, prices and full information.

281

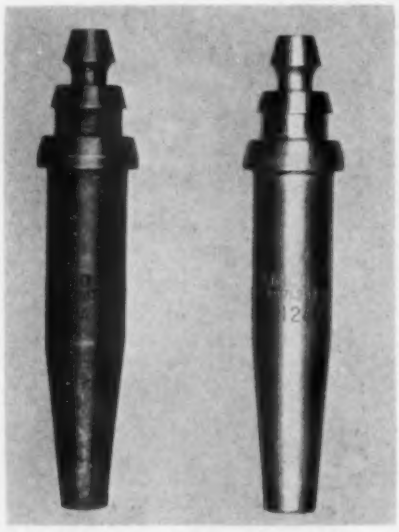
EMERSON ELECTRIC

MOTORS • FANS • APPLIANCES • A. C. ARC WELDERS

On the Job

Cleaning Torch Tips

AFTER a period of normal use, welding and flame-cutting tips acquire a deposit of carbon, slag, scale and tarnish. The orifices become congested or clogged—a condition which usually prevents utilization of the correct pressures, affects the operating efficiency and wastes critical oxygen and acetylene.



A torch tip before and after cleaning by the new method described in the accompanying text. The tips come out of solution looking and working like new, and it is not necessary to employ drills or wires to open the orifices.

Obviously, it pays to keep torch tips clean. But what is the best way to handle this work on a fast production basis?

The usual method is to employ drills to open and clean the orifices and then buff and scrape the surfaces of the tips to remove the carbon, scale and tarnish. This takes time, and there is, moreover, the ever present danger of mechanical injury to the tips through the use of wire cleaners or drills.

With a new time-saving method, one metal-working concern now cleans 500 tips in three hours, using one employee. Formerly, four workers spent seven hours in cleaning 200 tips. The actual time required for tip maintenance is thus cut in half and, at the same time, three employees are released for different work.

Details of the method are as follows:

The tips are placed in a basket and immersed in a boiling cleaning solution for from 45 minutes to one hour, followed by a cold rinse. Next they are immersed in a solution of Oakite Compound No. 32 to remove carbon, slag and scale deposits, followed again by a cold rinse. The tips are now given a ten minute bright dip, followed by a cold rinse and then by a boiling rinse prior to drying with an air blow. This sequence of operations takes approximately 90 minutes.

» «

Brazing Tipped Tools

THE shortage of high speed steel has led to the development of a process for furnace brazing and hardening tool tips at General Electric's Schenectady works. Reamers, planing tools, forming tools, dovetailed forming tools and cut-off tools are among those that have been prepared by this method. Hardness tests of the high speed steel tips indicate hardnesses of 64-65 Rockwell C.

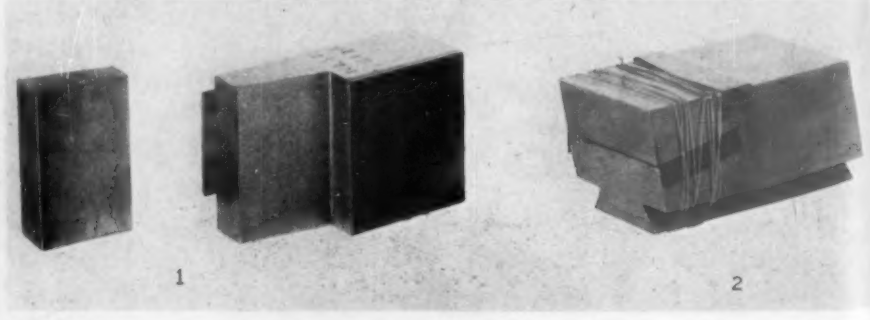
In the new process, the tool blank is first rough machined, and the part which has to be tipped is ground. A tool tip of high speed steel is then ground to meet the exact contour of the blank. To secure a better bond, the tip is nickel plated. Now a 0.005 in. shim of brazing alloy is inserted between the shank and tip, which are both covered with a suitable flux while the tip is held in place with chrome-nickel wire.

The brazing and hardening operations are performed in an electric furnace in a "controlled atmosphere" of drycolene. Steels treated in this gas are free from surface changes such as decarburization, carburization and oxidation.

The tool is put into the furnace without preheating and is kept there until it heats up to a temperature of 2,375 F (2,250 F for molybdenum steel). It is then carefully removed and quenched in oil until it turns black, approximately 1,100 F. After cooling in still air, it is tempered two hours at 1,050 F, air cooled and retempered one hour at 1,050 F, and again air cooled. After this, it is ready for finish grinding.

No complete life tests of such tools have been made so far, but tests of forming tools on stainless steels at 120 surface-feet per minute have proved wholly satisfactory.

Dovetailed forming tool showing (1) high speed steel tip and nickel steel shank and (2) the assembly prepared for furnace brazing.



Welded Air Raid Whistle

A COMPARATIVELY inexpensive air raid whistle, built from arc welded pipe and fittings, was devised by Hervey N. Beishline, steam plant foreman at the Magee Carpet Co., Bloomsburg, Pa.

Courtesy, The Lincoln Electric Co.

Arc welded air raid whistle invented by Hervey N. Beishline and installed at Bloomsburg, Pa.

The bell is constructed of 4 in. diam. pipe, 14 in. long, welded to a ½ in. disc at top and with a chamfer on the inside of the bottom. The outside frame supporting the bell is made of ⅜ by 1¼ in. mild steel bar, 24 in. long. A ¾ in. pipe sleeve, 3 in. long, is cut in half to serve as the bell adjustment, and a 1¼ in. pipe connects the whistle with the steam supply.

Steam goes through the whistle at all times. The method of operating the warning is to pull valve No. 1 wide open and then pull wire No. 2, which is connected to the bell lever, and release after an interval of approximately 10 seconds.

The counterbalancing weight (upper left corner of illustration) must be sufficient to return the bell lever and wire to normal position. When this weight is lowered, the pitch becomes higher, and as it is raised, the pitch is lowered.

Women Weldors

THE "heavy duty" environment of a steel mill is not usually considered the proper place for women workers, but women are now being found there in ever increasing numbers. As evidence

Courtesy, United States Steel Corp.

Wide application of welding and flame-cutting has speeded up many important war manufacturing operations in the nation's steel plants. Large numbers of women are being trained for this work.

of this trend, the United States Steel Corporation's annual report for 1942 carries the accompanying illustration showing an instructor giving lessons in welding to two girl apprentices. Thousands of women are also being trained for such jobs as operators of presses and cranes and as laboratory technicians in an intensified training program to help solve the war man-power problem.

» «

Bar-Cutting Simplified

PORTABLE flame-cutting machines of a new type for bars are being used in steel plants for various purposes.

Courtesy, The Linde Air Products Co.

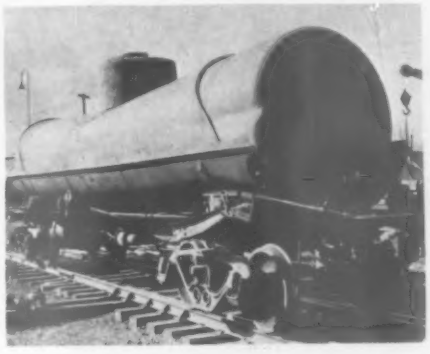
This operator is squaring bar ends with a new flame-cutting machine. The thin oxide scale shown adhering to the cut surfaces can easily be knocked off, leaving a clean, square cut.

They will square the ends of rolled bars (see illustration), remove etch-test specimens, cut bars to length for shipment from the mill or divide them into the lengths required for individual forgings. This machine requires neither electric power nor track on which to operate; it is positioned directly on the material to be cut, which may be either round or square bars. The cutting torch is guided automatically along the contour of the bar by means of a swinging mechanism actuated by an hydraulic power unit.

» «

Crushed, But Not Leaking

AN 8,000 gallon, single compartment welded tank car was recently severely crushed in a railroad collision which sent cars hurtling down an embankment. The tank car rolled over completely; its dome caved in the top tank sheets and both main heads were badly deformed.



Courtesy, American Car and Foundry Co.

The seams of this tank, fusion welded by the submerged melt process, did not leak even after the heavy damage depicted here.

Before making any repairs, the tank was tested for leakage. Not the slightest sweat leak in the welded seams could be found.

Courtesy, Hobart Brothers Co.

Welded pipe stilts built to raise oil tank 22 ft above ground.

Refineries on Stilts

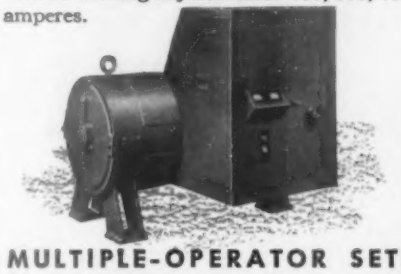
TO GUARD against the flood stages of the Ohio and Wabash rivers, oil refineries in the Wabash bottoms of Gallatin county, Illinois, are now mounting their pumps and tanks on 22 ft stilts. The stilts are usually built by local job shop weldors from old drill pipe.

for PRODUCTION A-C WELDING

Whether it's a problem of training new operators quickly or of improving present weld quality, Westinghouse a-c welders, with their freedom from arc blow, can help you. 100, 200, 300 and 500-ampere models. Also 1000-ampere models for use with the Unionmelt process.

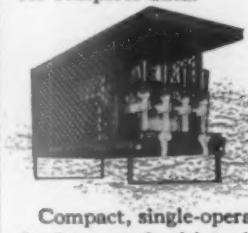
NEW D-C WELDER with ARCONTROL

Single, pre-set current adjustment. Lots of capacity to handle all kinds of work. No drop-off after warming up—less lost motion making adjustments. 200, 300, 400 amperes.



MULTIPLE-OPERATOR SETS

Do the work of 20 to 30 single-operator rotating sets. Stationary types for shop operation—semiportable types for use on shipways and similar applications. Ask for complete data.



PORTABLE TACKING PANELS

Compact, single-operator control panels for fit-up work with multiple-operator sets. Extra capacity for light tack welding.

Write for latest literature. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

J-21269

Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

WELDERS

BEST RESULTS In Bronze Welding Are Assured With

TITAN BRONZE WELDING ALLOYS

For all types of oxy-acetylene bronze welding and brazing—on copper, cast iron, bronzes, brasses, nickel-brasses, copper-silicon alloys, cupro-nickels—the uniform high quality of Titan Alloys gives welds that consistently meet rigid tests.

TITAN rods flow freely, penetrate seams and crevices and provide extremely dense, non-porous welds. They are widely used because:

- Double Deoxidation, a development of TITAN metallurgists, increases ductility of the weld, reduces fuming to a minimum and assures a sound, dense deposit.
- Titan Alloys are exceptionally low melting.
- Only the purest of raw materials are used. Electrolytic copper 99.96 plus in purity and electrolytic zinc 99.99 plus.
- Absolute uniformity is assured by strict laboratory control of mixtures and casting temperatures.

Three Distinct Groups:

MUNTZ TYPE: General purpose rods for high-strength ductile welds. PENN BRONZE, doubly-deoxidized, low-fuming rods, flow at 1628° F; and TITAN BRAZING BRONZE flows at 1625° F.

TIN BRONZES: Hard corrosion-resisting welding rods especially suited for cast iron. TITAN BRONZE is doubly-deoxidized and low fuming, flows at 1617° F. TITAN NAVAL BRONZE flows at 1615° F. TITAN WEARWELL BRONZE flows at 1593° F. Wearwell is a special-purpose rod possessing great hardness; especially suited for building up worn surfaces and for bearing service, etc.

MANGANESE BRONZES: General purpose rods, especially recommended for cast iron. TITAN MANGANESE BRONZE is doubly deoxidized, low fuming and flows at 1617° F. TITAN NAVAL BRONZE flows at 1620° F.

Write today for free literature describing more fully the complete line of TITAN Welding Alloys.

TITAN
Metal Manufacturing Co.
BELLEFONTE, PA.

Underwater Welding

UNDERWATER resistance welding is replacing soldering or brazing processes for the joining of copper cable to terminals at the East Pittsburgh works of the Westinghouse Electric and Mfg. Co. This task, formerly a hand operation, is now a production line job.

Welding under water speeds production and improves quality. The continuous stream of cooling water passing across the jig does not interfere with the placement of the parts being welded. The cupaloy tips may be quickly changed for different types of assemblies.

Essentially, the new process consists of resistance welding with special electrode tips while a stream of water plays over the stranded wire. A welding machine with one fixed and one movable electrode is used. A special jig is fastened around the stationary electrode to hold the cable and terminal firmly in welding position. The electrode tips, mounted in water-cooled holders, are of carbon or of molybdenum and cupaloy. Cupaloy tips with molybdenum inserts have been found most satisfactory for welds that do not require flux, but carbon tips are required where flux is used. The inserts that contact the wire are grooved to prevent the cable from being flattened.

The machine is air-operated and is timed by electronic controls. For a typical weld—the welding of 2,352 strands of 0.002 in. diam wire to an 0.037 in. thickness of copper—the technical data is as follows: time, 38 cycles (based on a 60 cycle basis); current, 14,400 amp; electrode pressure, 400 lb. Cupaloy tips with molybdenum inserts at both top and bottom were used.

In the lower end of the same assembly, the wire was welded to two pieces of 0.020 in. thickness of tinned copper. A time of 26 cycles was required with the same 14,400 amp current and 400 lb electrode pressure.

In the underwater resistance weld, the wire cables remain flexible to the point of the weld, while in both the soldering and brazing processes the molten metal cools only after being drawn into the hot cable by capillary action. Cooling of the parts with water while welding removes heat from the immediate area of the weld before it can pass to more distant areas. Thus the original metallurgical structures are not changed.

Announcing

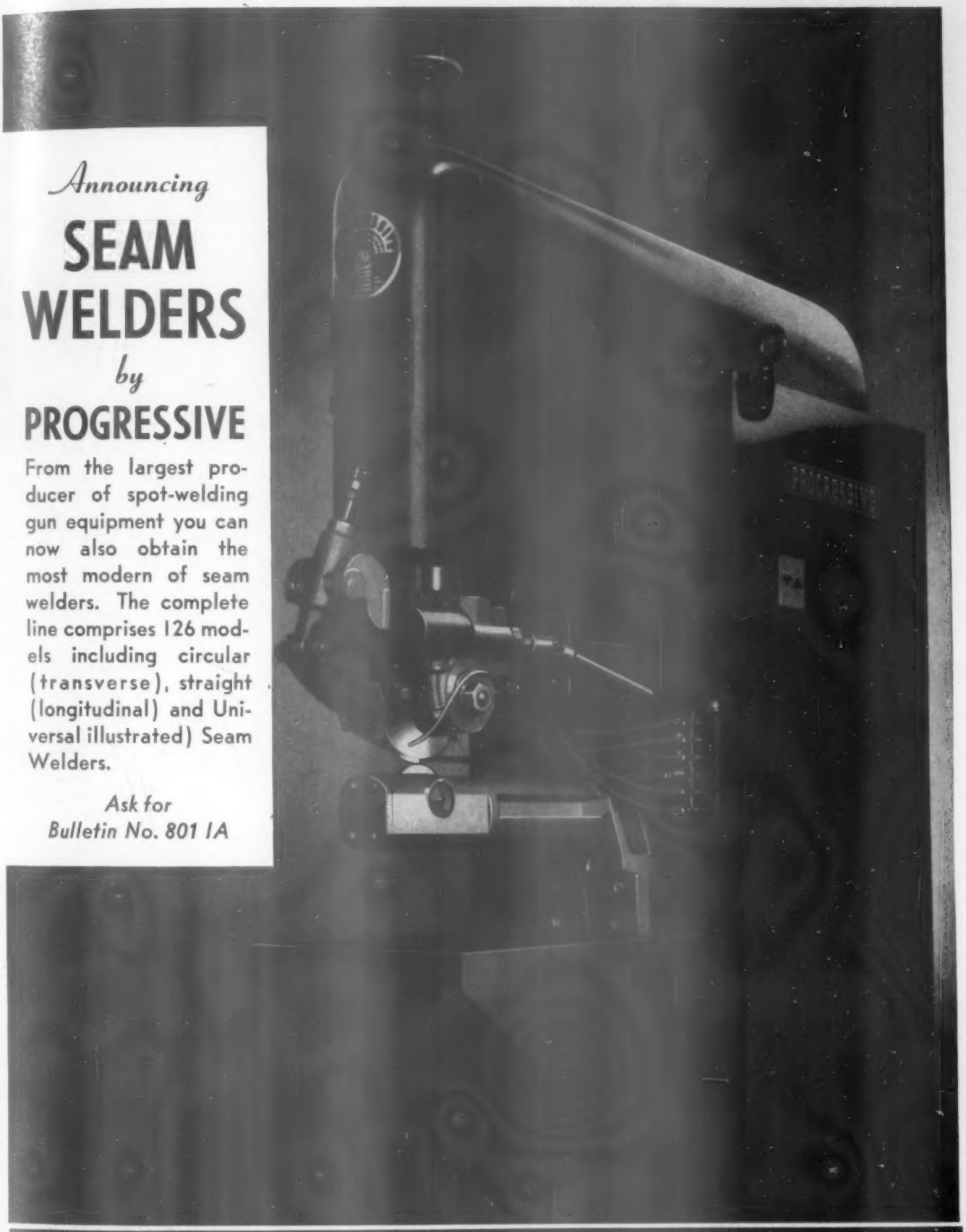
SEAM WELDERS

by

PROGRESSIVE

From the largest producer of spot-welding gun equipment you can now also obtain the most modern of seam welders. The complete line comprises 126 models including circular (transverse), straight (longitudinal) and Universal illustrated) Seam Welders.

Ask for
Bulletin No. 801 IA



PROGRESSIVE WELDER CO.

SEAM, PROJECTION & BUTT . . . *Electric Welding Equipment* . . . PORTABLE GUN & PEDESTAL

3050 E. OUTER DRIVE DETROIT, U.S.A.

New Products to Use

Glare-Eliminating Goggles

★ **American Optical Co.**, Southbridge, Mass., announces the development of a new eye-protective glass which enables oxy-acetylene weldors to pierce the glare of the flame and see welding operations from the beginning to the end. In all types of flame welding, the new **"Didymium-Noviweld"** safety goggle lenses cut down the high intensity sodium rays of the fluxes, permitting weldors to look right through the yellowish cloud of "flux-flare" and see the rod and the molten area more clearly. The lenses also protect eyes and lessen eye fatigue by absorbing the harsh, tiring ultra-violet and infra-red rays generated during welding.

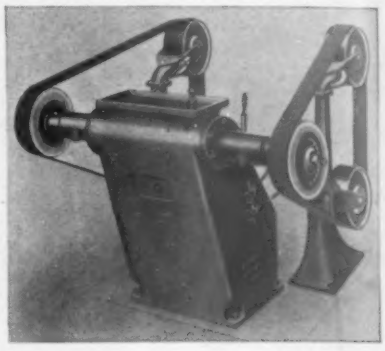
This gas welder is wearing goggles equipped with the new "Noviweld-Didymium" lenses which enable him to look right through the cloudy yellow flame of burning sodium vapors.

These new lenses are manufactured under strict laboratory control and meet the Bureau of Standards specifications for glare control. Three shades are available, Numbers 4, 5 and 6, corresponding with shade numbers of the standard AO Noviweld lenses.

» «

Abrasive Belt Unit

★ Regular lathes may be quickly and easily converted to belt grinding with the new **Abrasive Belt Backstand Idler No. 120**, a floor-type model especially designed for crowded grinding and polishing departments. This unit takes up a minimum of floor space because of the vertical arrangement of its pulleys. It will take any belt size up to 6 in. wide, is designed for belt speeds up to 10,000 surface feet per minute and is so built that dust-collecting hoods can easily be installed if desired. Full details may be obtained from Bulletin No. 120, available from the **Jones Engineering Co.**, E'lwood City, Pa.



Jones Backstand Idler. It converts regular lathes to belt grinding, speeding production through the use of factory-coated abrasive belts for grinding and polishing operations.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

C-F POSITIONERS
Speed Production and Job Welding

★

C-F POSITIONERS make welding a faster and more economical operation—save time, save man-hours. The welder himself turns and tilts and positions even the clumsiest and heaviest weldments with a push button control—without cranes, crane crews, hoist, jacks or "flopping" space. All sides can be welded down-hand—all welds can be made faster with heavier rods; made stronger, smoother and flawless.

C-F Positioners come in sizes and types for every welding need—range from small hand operated units for light job work to giant positioners that swing great weldments weighing 30,000 lbs. All have platforms that rotate the full 360° and tilt to 135° beyond horizontal. *All are adjustable for height and are pedestal mounted to give greatest floor clearance.*

Write for Bulletin WP 22.

CULLEN-FRIESTEDT CO.

1309 S. Kilbourn Ave. • Chicago, U.S.A.

Champion Welding Electrode handbooks are obtainable for distribution to apprentice classes.

● As Victory is reflected in the productive might of American industry, the shadow of the welder hovers over the crumbling bulwarks of the enemy.

Champion Welding Electrodes produce clean, smooth welds down to two inch lengths. All sizes and styles are available. Uncle Sam expects every operator to conserve by using the utmost utility in each electrode.

Be sure it's a stub before it's thrown away.

THE CHAMPION RIVET COMPANY

11500 Harvard Ave., CLEVELAND, OHIO

East Chicago, Indiana

(Advertisement)

A Little Metal Saves a Lot—*the Amsco Way* . . . . . .

Current uses of Amsco welding products present numerous instances where substantial quantities of critical metals have been saved, and important monetary savings effected at the same time.

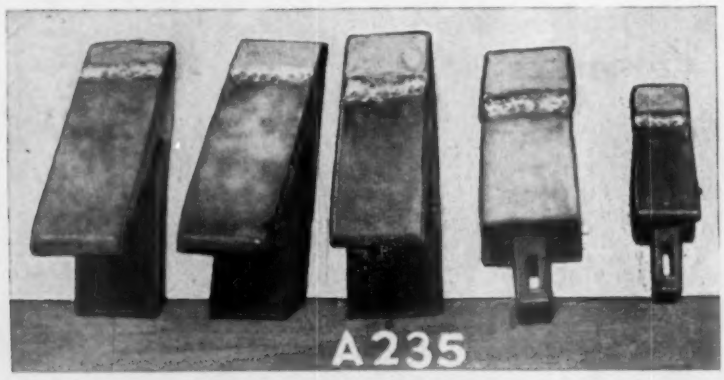
A Pennsylvania quarry forestalled rapid wear of its gyratory crusher concaves by hard-surfacing them with 1/4" Amsco Economy Hardface welding rod. This self-hardening rod is highly resistant to both impact and abrasion — much more so than the parent metal in this instance—and deposits with a Brinell hardness of 450 to 550.

The service life of the segments, one of which is shown in View A-234, was greatly increased. The cost of the hard-surfacing was much less than the frequent purchase of new and hard-to-get castings. Such applications permit the use of the more readily available metals, reducing consumption of scarce materials.

For obtaining additional service from badly worn equipment parts, such as bucket teeth, tractor grousers, dipper fronts and cutter head blades and teeth, Amsco cast repointer bars or rolled special shapes have proved effective. After using Amsco Nickel-Manganese Steel welding rod to weld on the repointer bar and fill the voids, one of the Amsco hard-facing welding rods can be applied. The dipper teeth shown in View A-235 were salvaged by repointing and hard-facing by a Canadian job welding shop — a little metal used to save a lot.

These times demand the application, where possible, of rebuilding and hard-facing to insure maximum service life from ferrous equipment parts subjected to abrasive or frictional wear.

Write for Bulletin 941-W on Amsco Welding Products.



Amsco
AMERICAN MANGANESE STEEL DIVISION
Chicago Heights, Illinois
THE AMERICAN Brake Shoe AND FOUNDRY COMPANY
FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST LOUIS, MO.
OFFICES IN PRINCIPAL CITIES

Thyratron Tube

★ **GL-502,** a new thyratron tube with both a control and a shield grid for control applications, has been announced for industrial welding applications where weight and space must be considered. The new tube is a little over 2½ in. long, weighs about two ounces, is inert-gas-filled and of all-metal construction. It has a maximum peak inverse anode voltage rating of 1,300 volts, an instantaneous current rating of 500 milliamperes and an average current rating of 100 milliamperes. The cathode is rated at 6.3 volts, 0.6 amp. Electronics Dept., **General Electric Co.,** Schenectady, N. Y.

» «

Safety Welding Attachment

★ The **"Safti-Kupler"** is a portable unit attachable to any type of A-C arc welder for removing the chance of an accidental electric shock. It is set up at any convenient spot near the welder and connected to it by means of an 8 ft cable. When the welder current is switched on, a green light (operations light) flashes to indicate that the welder and the welding cables are in safe electrical working condition and that there is no welding current of any kind present in either cables or the electrode holder. The instant the operator strikes an arc, the green operations light goes off and a red warning light flashes on. This indicates that a potential of dangerous voltage, high amperage and oscillating frequencies are present in the cables and electrode holder, which condition is safe to the operator only during the actual contact of the electrode, through its arc, to the work. When the operator ceases to weld and breaks the arc, even momentarily, the red light is replaced by the safety green, and the welding potential and oscillating currents are cut out from the welding cables. Even the A-C resurge current induced in the welder transformer field is blocked out. When welding is restarted, the red light comes on again.

If the red light should appear immediately after the switches have been turned on but before the arc is established, a dangerous short circuit somewhere in the welder-cable system is indicated. **A.C. Devices Co.,** 2608 N. Cicero Ave., Chicago.

» «

Welding Time Recorder

★ The **"Time-Taker"** is an electrically operated welding time recorder for keeping accurate account of the actual welding time on any particular job. The hours and minutes being spent in welding are indicated by the changing figures which appear in a window of the device. Overall size of the Time-Taker is 4 by 5 by 9 in., and the figures shown in its window are 5/8 in. high.

To operate, the Time-Taker is plugged into the outlet on the top of a "Safti-Kupler," an attachment for A-C arc welders. **A.C. Devices Co.,** 2608 N. Cicero Ave., Chicago.

Independent Engineering Co.

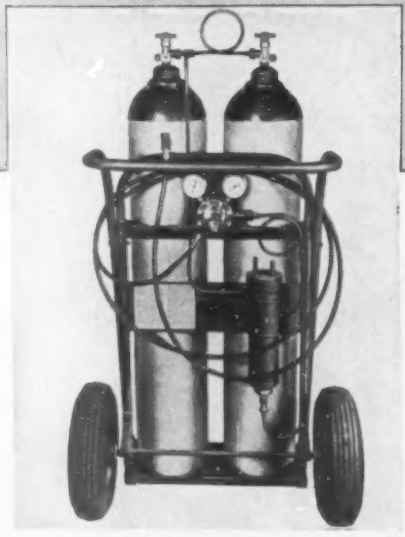
CYLINDERS *and* Cylinder Transports

For the Armed Service Until

VICTORY Is Won

☆ **All shipments of Independent Engineering Co. Cylinders are under complete control of the armed forces except where adequate priority, otherwise, is available. We are proud of the outstanding record we have achieved in meeting their requirements. When peace comes, these achievements in pioneer engineering design, construction and production will be at the disposal of all—a record that will make Independent Engineering Co. products a *first* thought when industrial gas producing, packaging and transporting equipment are under consideration.**

Mammoth Cylinder-Transports, built by Independent Engineering Co., (as illustrated below) make possible the efficient, economical delivery of large quantities of industrial gases in a single unit to any given point with a minimum of delay . . . a valuable contribution to the Service of Supply.



Thousands of Independent Engineering Co. Rechargers now serve the war cause and those who serve the war effort. The final step in the Service of Supply—these—flexible, easy-to-handle units are used to distribute cylinders to the point of usage.

Independent Engineering Co.—Pioneer designers and producers of mobile Oxygen and Hydrogen generating plants for the armed forces...builders of Oxygen, Hydrogen and Acetylene plants — manufacturers of industrial gas cylinders and cylinder handling equipment.

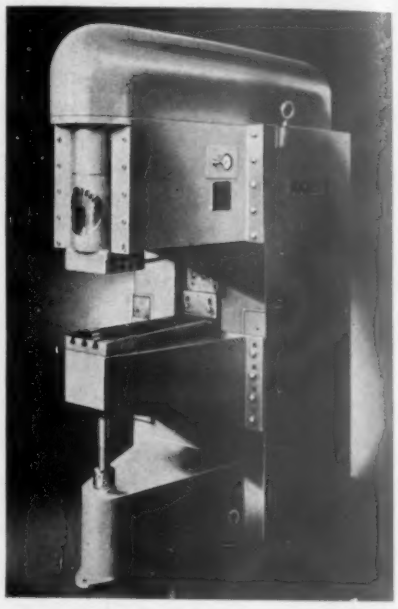
Independent Engineering Co.

101 West Second Street, O'Fallon, Illinois

CHISEL
EDGES THAT
Pierce ARMOR
PLATE with ease
YET RETAIN
UNMARRED
CUTTING
EDGES
6¢
WORTH OF
AGILE Silver-Green
WELDING ELECTRODE
MADE THIS CHISEL
The above unretouched photograph was obtained after the AGILE-made chisel was driven thru the ¼" armor plate with only five hammer blows. AGILE Silver-Green electrodes contain all the features of hardsurfacing, strength, toughness and hardness. Hardness 55-60 Rockwell C. Full information furnished on request.
AGILE ACTARC
AMERICAN AGILE Corporation
5806 HOUGH AVE. · CLEVELAND, O.

Press Welders

★ A complete line of press welders is announced by the **Progressive Welder Co.**, 3050 East Outer Drive, Detroit. There are four basic types—light duty, medium duty, heavy and extra-heavy duty, each type being available in from four to six kva capacities and in a variety of throat depths. Each model is



Progressive press welder, light duty type, available for either motor or air operation. The dies and platens are water cooled.

available in either air-operated or motor-driven style, while the extra-heavy models are also produced with hydraulic operation. All models are fitted with universal T-slot platens for the mounting of fixtures and dies and with double cooling water manifolds. The latter are provided with a series of outlets to permit connection of up to six die-cooling circuits. The platens are also water cooled.

» «

A-C Electrode

★ **Murex Type A,** a new all-position A-C electrode, has been developed to meet the requirements for grade E-6011 electrodes under AWS—ASTM specification A-233-42T; for grade III, classes 1 and 2, under U. S. Navy Bureau of Ships specification 46E3; and for grades H1G, B1G and E2G, American Bureau of Shipping. With this new A-C electrode, manufacturer states, overhead and vertical welds can be made without the use of a highly specialized welding technique.

The new electrode is available in diameters of 3/32, ⅛, 5/32 and 3/16 in. Typical physical properties of the weld metal, as welded, include yield points of 52,000 to 61,000 psi, ultimate strength of 62,000 to 71,000 psi and an elongation of 22% to 26% in two inches. **Metal & Thermit Corp.**, 120 Broadway, New York City.

Built for continuous **PRODUCTION**

IDEAL FOR TRAINING

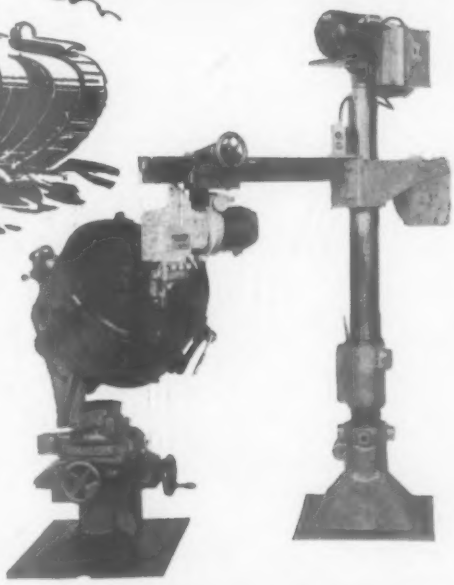
HERE'S A WELDER built to stand the gaff... well suited for training and equally capable when schedules call for production around the clock. It is NEMA rated 250 amperes output, with a welding range from 310 amps. maximum down to 40 amps. Operates at either 220 or 440 volts. Includes all the G-R features: stepless heat control; spun glass and mica insulation; power factor correction.

NEW LOWER PRICE... made possible by volume production... NOW $285.00
(F. O. B. DESTINATION)

SEE YOUR NEAREST DISTRIBUTOR or WRITE FOR INFORMATION

GLENN-ROBERTS COMPANY
1009 FRUITVALE AVENUE, OAKLAND, CALIFORNIA
Indianapolis, Ind.: P. O. Box 1556 · Washington, D. C.: P. O. Box 1814

Quicker Welding . . With This
Automatic Welding Machine Fixture



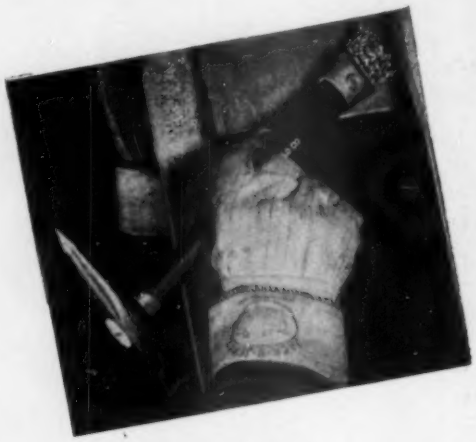
Reloading Is done During Welding Operation

THIS Acme dual fixture arrangement permits practically constant use of an automatic welding head, because one of the fixtures can be reloaded while the other is engaged in the welding operation.

The holding machine can be set to revolve at any angle from vertical to horizontal. (Illustration shows a wheel being welded at 45° angle.) Positioner arm swings from one fixture to the other, locking in proper position. Speed of rotating the work is adjustable, as desired.

ACME *Manufacturing Co.*
1642 HOWARD ST. • DETROIT, MICH.

WRITE
for information. Whatever your positioning problem on automatic welding, let us help you solve it. Write for complete information.



TYPE CB
TRIPLE-DUTY
HAMMER

Combines chisel, drift and removable brush in one time-saving tool. Weight 16 oz.

CMD

Welders' Chipping
HAMMERS

Have The Features Welders Want

"THEY STAY SHARP LONGER"

Eighteen years of experience behind CMD Chipping Hammers are your assurance that these tools have the practical features welders want and must have for fast, efficient cleaning.

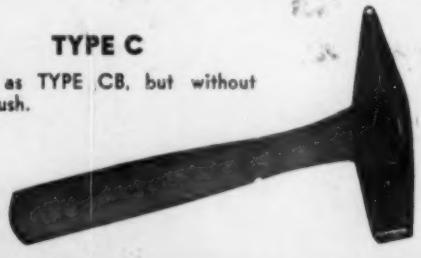
"THEY ARE LIGHT AND EASY TO USE"

Because the heads of CMD Chipping Hammers are of exceptionally hard, carefully tempered steel, they hold their cutting edges longer and can take more regrindings when sharpening becomes necessary. CMD Hammers are also light in weight and well balanced for easy use from any position—a feature especially appreciated in cleaning overhead welds. The heads are securely anchored to withstand the severest usage.

"THE HEADS DON'T WORK LOOSE"

TYPE C

Same as TYPE CB, but without the brush.



Order from your Welding Supply House

If they cannot supply you, order direct! Descriptive circular sent free upon request.

CHICAGO MANUFACTURING AND DISTRIBUTING COMPANY
Dept. W., 1928 West 46th St., Chicago, Illinois

Goggle cleaning station. A tap on the center inverted vial sprays an anti-fogging fluid on the lens, which is then wiped with optical cleaning tissue.

Goggle Cleaning Unit

★ The new **M.S.A. goggle cleaning station** makes it easy for workers to keep their goggles clean. Designed for convenient wall mounting, the unit consists of a case equipped with "Fogpruf"—lens cleaning and anti-fogging agent—and optical wiping tissues. A tap on the inverted vial sprays Fogpruf on the goggle or spectacle lens. **Mine Safety Appliances Co.**, Braddock, Thomas and Meade Streets, Pittsburgh.

» «

Heavy duty Steel-Grip glove No. 12517 as adapted for women workers. Glove may also be obtained with a 2 in. band instead of gauntlet.

Women's Reinforced Glove

★ A steel reinforced gauntlet for women workers handling rough, jagged materials has just been announced by the **Industrial Gloves Co.**, Danville, Ill. Designed on small, comfortably fitting patterns, these gauntlets are made of chrome tanned leather that has been reinforced on all wearing surfaces with diagonally placed steel ribbons. The seams are sewed with steel thread, and extra leather and steel ribbons are used to reinforce the thumb wearing surface and the junction of palm and thumb.

(New Products continued on page 69)

NEMA Welding Electrode Standards

Classes of Electrodes

(A) Bare Electrodes

Any mild steel electrode whose surface has not been improved for the purpose of improving the welding qualities, etc., beyond that improvement obtained through normal wire drawing practice. Final annealed wire is included in this classification.

(B) Thinly Coated Electrodes

Mild steel electrodes designed to improve the stability and performance of the arc stream (coatings intended to change materially the physical or chemical properties of deposited materials are in Class C). Included herein are washed, sprayed, brushed, tumbled, drawn, heat dipped, or otherwise made thin coatings.

(C) Heavily Covered Electrodes

Mild steel electrodes whose covering is designed to improve the physical properties of the deposited weld material. Extrusion, wrapping, dipping or combinations or other means are included in this classification.

(D) High Tensile Electrodes

All ferrous electrodes whose alloys are added to give tensile strength above 75,000 psi in the weld metal in the "as welded" state.

(E) Hard-Facing Electrodes

All electrodes producing a weld deposit whose property is primarily to control hardness or resist wear such as 12% manganese electrodes, tungsten-chromium electrodes, high carbon steel electrodes, etc.

(F) Ferrous Electrodes for Welding Cast Iron

All ferrous electrodes principally used for the welding of cast iron.

(G) Corrosion and Scale Resisting Alloy Electrodes

All electrodes giving a weld deposit containing chromium or chromium and nickel as the principal alloying elements, the purpose of which is to obtain a weld deposit to resist corrosion at normal or at elevated temperatures. The following classifications fall in this group:

(G-1) Stainless Electrodes

All electrodes giving a weld deposit containing chromium in excess of 1.75% chromium, chromium being the principal alloying element. (These are the so-called straight chromium alloy electrodes.)

(G-2) Chromium-Nickel Electrodes

All chromium-nickel electrodes giving a weld deposit of the corrosion and scale resisting types.

(H) Non-Ferrous Electrodes

All electrodes producing a weld deposit of essentially non-ferrous elements, such as copper, bronze, aluminum, nickel, copper-nickel, etc.

(I) Miscellaneous Electrodes

All electrodes of a type or for purposes not defined under Classes A to H inclusive.

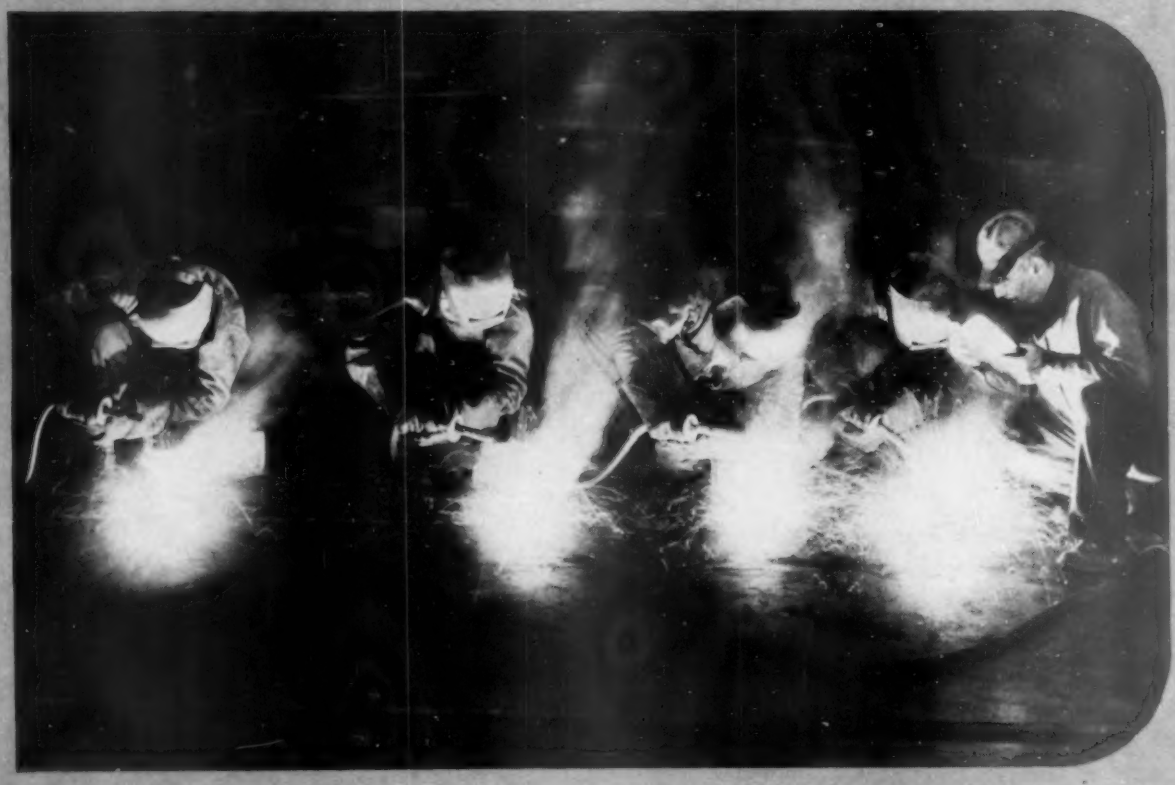
Two-color Marking for Heavy Coated Ferrous Electrode Identification

Spot or Secondary Color	END OR PRIMARY COLORS										
	Mild Steel & Low Alloys						Chrome Nickels				Chrome Alloys
	All Position	Horizontal Fillets and Flats		Flat Only	Special Purpose	Hard Surfacing	25-20	18-8	25-12	Misc.	
	No Color	Blue End	No Color	White End	Orange End	Brown End	Red End	Yellow End	Black End	Green End	Gray End
No Color	EA-1 5/16V & Less E-6010	EA-2 E-6020	EA-4 1/4 inch only	EA-3 E-6030	Mild Steel for Cast Iron	.40-.70 Carbon	Type 310	Type 304	Type 309	15-35 Type 330	2% Cr-Mo
Blue	E-6011			Smooth Final Pass	Monel	.90-1.10 Carbon	25-20 Cb	18-8 Cb Type 347	25-12 Cb	13-60	± 6% Mo Type 502
White	E-6012				Cast Iron for Cast Iron	Brinell* 200+	25-20 Mo	18-8 Mo Type 316		20-80 15-80	10% 1% Mo
Brown	E-6013				.5-1.0% Ni	Brinell* 300+		18-8 Mo Type 317		8-21 Type 325	12% Type 410
Green	x Navy Class 1 / x Navy Class 4 E-7010	x Navy Class 2 E-7020		E-7030	2-3% Ni	Brinell* 400+		18-8 Mo Cb		20-25 Type 311	16% Type 430
Red	E-7011				12-14% Mn Steel	Brinell* 500+		18-8 Si Type 302B		29-9 Type 312	20% Type 442
Yellow					Ni-Mn Steel	Brinell* 600+		18-8 Ti Type 321		28-3½ Mo Type 329	26% Type 446
Black	.80 Mo			.80 Mo	Ni-Cr Mo	Brinell* 700+		18-8 Mo			30%+
Orange	E-6010 3/16 inch Std Coat				Ni-Cr Cu			18-8 Mn			17-3%W Type 438

*Hardness to be determined from the third layer of a 3x3 in. deposit on a 1 in. mild steel plate 5x5 in. Each layer must be allowed to cool to room temperature in still air. Use ¼ in. diam. electrode for test purposes.

xThese are carbon Moly Electrodes Navy Specification 46 E 2 (Int)-2-1-41.

NOTE—In case of center grip electrodes, end (primary) color will be central and spot (secondary) color on each side.



MAKING BETTER TIME— *There is still a shortage of welders skilled in specific jobs and many industries find they get on with their production program faster by "work-training" groups of men in the technique they must acquire to reach top production.... As you check on your men, continue, also, to see that they use electrodes of correct analysis and size—see that they deposit no excess metal in the weld—make certain that they use the electrodes right down to the holder. With the tremendous increase in the use of welding electrodes it has become vital to stop waste.*

PAGE WELDING ELECTRODES

PAGE STEEL AND WIRE DIVISION Monessen, Pa., Atlanta, Chicago, New York, Pittsburgh, San Francisco

AMERICAN CHAIN & CABLE COMPANY, Inc.

BRIDGEPORT • CONNECTICUT

ESSENTIAL PRODUCTS . . . TRU-LAY Aircraft, Automotive, and Industrial Controls, TRU-LOC Aircraft Terminals, AMERICAN CABLE Wire Rope, TRU-STOP Brakes, AMERICAN Chain, WEED Tire Chains, ACCO Malleable Castings, CAMPBELL Cutting Machines, FORD Hoists, Trolleys, HAZARD Wire Rope, Yacht Rigging, MANLEY Auto Service Equipment, OWEN Springs, PAGE Fence, Shaped Wire, Welding Wire, READING-PRATT & CADY Valves, READING Electric Steel Castings, WRIGHT Hoists, Cranes, Presses . . . *In Business for Your Safety*

New Products to Use

(Continued from page 64)

Electrode Holder

★ The Tweco **"Type H Standard"** electrode holder features all the advantages of the "Standard" holder plus the additional feature of quick connection or disconnection from the welding cable. The "Type H Standard" is equipped with a special male plug adapter inside of the holder handle to receive the female end of the No. 2 "Sol-Con" cable connector. To illustrate the application more clearly, the accompanying illustration shows the male plug end being inserted into the holder; normally, however, it is the female end of the connector which is snapped onto the holder. The holder can be quickly detached at the cable end or may be "jumped in" at any point along the welding current circuit where "Sol-Con" cable connectors are used. **Tweco Products Co.**, English at Ida, Wichita, Kansas.

Tweco "Type H Standard"

» «

Peer P-100. An automatic press-type combination projection and spot welder, available in transformer capacities of 75, 100 and 150 kva.

Spot and Projection Welders

★ **Series P-50** and **P-100** automatic air-operated, press-type welding machines have recently been added to the line of resistance welding equipment made by the **Pier Equipment Mfg. Co.**, Milton and Cross Sts., Benton Harbor, Mich. These welders are designed for high speed, precision projection and general spot welding of sheet and structural steel assemblies and also wire.

These welders are equipped with double acting air cylinders and control valves. Pressures are adjustable within a range from 800 to 4,000 lb. Die platens with T-slots hold the projection welding dies. For spot welding, there are supplied 2½ in. diam copper horns.

» «

Heavy Duty Drill

★ **Skilsaw, Inc.**, 5033 Elston Ave., Chicago, announces its new **Model "47" Skildrill.** Though designed especially to speed up tough "skin-drilling" in airplane production, the new drill has a great variety of other uses and may be used for jobs up to ¼ in. in steel and ½ in. in wood. It is compact (7¼ in. long by 2 9/16 in. wide), lightweight (3½ lb) and fits in anywhere that a fist will. The Universal motor is available in four speeds—1,800, 2,500, 3,500 and 5,000 rpm.

Model "47" Skildrill for production drilling jobs up to ¼ in. in steel and ½ in. in wood.

Prompt delivery of vitally needed welding equipment and electrodes is a "blessed event" for industry engaged in all-out war production.

But speed of delivery is only a foretaste of what a MARQUETTE does in production or maintenance work. Five superb models, 150 to 400 ampere capacity, deliver perfect current for fast, flawless welding of light sheets or the heaviest type of industrial production.

Instantaneous heat selection, automatic voltage control, no confusing dials or gadgets, no "magnetic blow," all-asbestos insulation, no moving parts to wear out . . . are MARQUETTE features that assure strong, uniform welds at top welding speeds.

Capital investments under the new priority regulation will pay their biggest dividends when used for versatile MARQUETTE machines whose matchless performance will help you to make prompt delivery of your products to their place in the war effort.

Send for free, 24 page, illustrated booklet.

MARQUETTE MFG. CO., INC.
MINNEAPOLIS, MINN.

MARQUETTE
REG. U.S. PAT. OFF.
A.C. ARC WELDERS

Refrigerated Electrodes

A new development in resistance welding electrode design, said to make possible the full utilization of refrigerated welding for the first time, is announced by **Frostrode Products,** 19003 John R St., Detroit. Among advantages claimed for the new **"Frostpoint"** electrodes and "Frostrode" electrode refrigerating process are: (1) increases of from 600% to 1,000% in the number of spot welds which can be made before the tips require dressing; (2) a 90% saving in the copper normally required for resistance welding electrodes due to the fact that the "Frostcap," a quick-replaceable tip on the end of the electrode, is the only part that needs replacing; (3) a recapping cost of only a few cents as against the usual cost of a complete new electrode; (4) self-sealing method of assembly which insures that the electrode will be positively sealed against leakage; (5) the greater cooling area obtained by internal integral finning of the "Frostcap" which insures a maximum heat dissipation to the coolant; (6) accurate control of coolant flow through the electrode.

The new "Frostpoints," it is stated, can be used on any existing welder. For installation, an adapter is inserted in the standard electrode holder of the machine. When installed, normal cooling water circulation extends only as far as the adapter. From the adapter to the "Frostcap," cooling is handled by the "Frostrode" coolant. Thus the refrigerated cooling is concentrated at the base of the electrode where it is most needed.

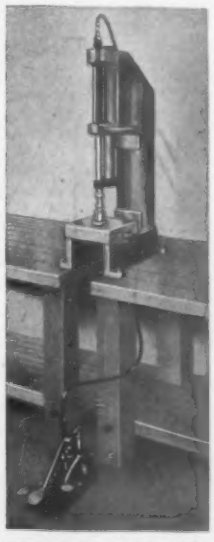
To replace, the cap is gripped in a pair of "electric pliers" which melt the solder seal and free it from the electrode. After a new cap has been slipped into place, the electric pliers are again applied, melting the solder to complete the seal.

Left: the new "Frostpoint" electrode with adapter fitting into a standard electrode holder (left) and the same holder with conventional electrode. Upper right: the replaceable "Frostcap" with its internal fins to insure a maximum heat dissipation to the coolant. Lower right: method of using "electric pliers" to replace a cap.

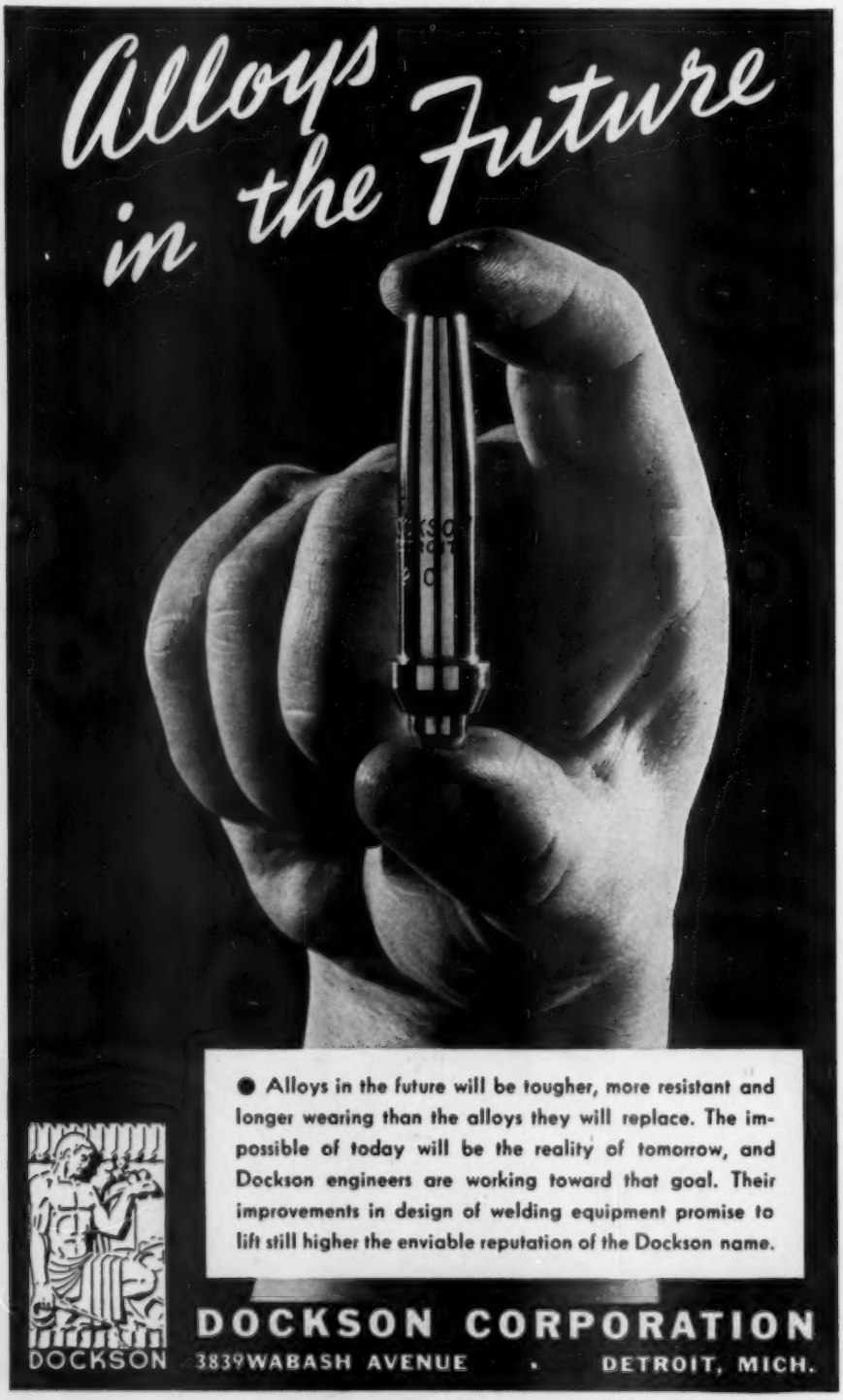
» «

Hydraulic Press

★ An entirely foot-controlled hydraulic arbor press has just been announced by the **Studebaker Machine Co.,** 9 South Clinton St., Chicago. This new **"Speedpress"** requires no hand levers and may be operated by women as easily and efficiently as by men. Pressures from zero up to 20,000 lb may be obtained.



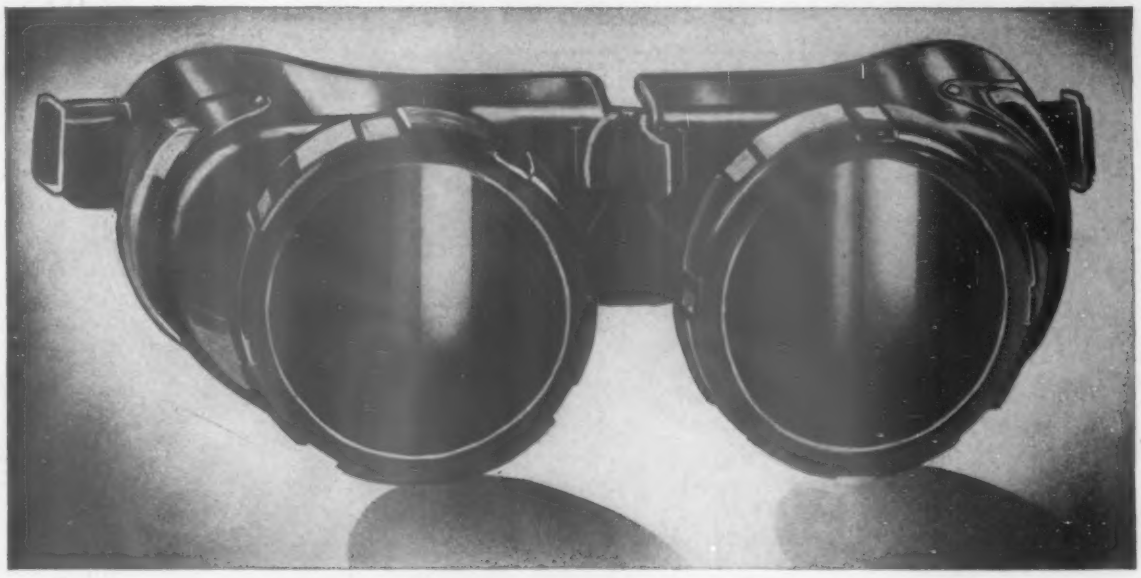
Studebaker "Speedpress." It handles press work that formerly tied up large and expensive equipment, but its ram pressure of 10 tons provides the needed capacity for heavier work.


Alloys in the Future
● Alloys in the future will be tougher, more resistant and longer wearing than the alloys they will replace. The impossible of today will be the reality of tomorrow, and Dockson engineers are working toward that goal. Their improvements in design of welding equipment promise to lift still higher the enviable reputation of the Dockson name.
DOCKSON
DOCKSON CORPORATION
3839 WABASH AVENUE • DETROIT, MICH.

Announcing Two New Numbers . . .

OVER-SPEC RIDO' RAY WELDERS' GOGGLES
RESISTAL CHIPPING GOGGLES

Fit perfectly over regular eye-glasses



No. 5963 Welda Goggle equipped with Welda Lenses
No. 5960 Chipping and General Utility Goggle equipped with genuine Non-Shatterable Lenses

Prompt Delivery . . .

Direct from the manufacturers or through your local distributor

Send for descriptive literature
Samples sent on request

Sole Manufacturers

HARRY BUEGELEISEN, INC.

Mfrs. of Welders' Goggles, Chipping Goggles, Lenses for Goggles and Helmets

181-183 PACIFIC STREET • BROOKLYN, NEW YORK

Helpful Literature Just Published

The following reviews are of recent publication of interest to those in the welding industry. Unless otherwise stated, they may be obtained without cost by writing to the manufacturer or to **THE WELDING ENGINEER.**

Alloy Finding List

First bulletin in a new information service being offered by Hobart is **"Alloy Metals Finding List and List of Sources,"** a 16-page, letterhead-size booklet. This finding list is distinct from other compilations of this character in that the alloy metals are classified by ten characteristics listed in a numbered code. The desired characteristics of an alloy metal are first identified by their code numbers, and the proper alloy metal is then located by means of corresponding numbers in the finding list. For example, suppose that the characteristics of corrosion resistance, abrasion resistance and bearing application are desired in one alloy; these three qualities are looked up in the characteristic code and found to possess the numbers one, three and six. Running down the left side of the finding list, such a combination of numbers is found opposite the alloy "Castoloy." In addition to the trade name of the alloy, its principle constituents and a source index, in this case D-2, are also given. The source index is used to locate the name and address of the company from which the indicated alloy metal can be obtained.

Later bulletins on NE alloy steels, new building specifications, elements in alloy steel and the welding of nichrome alloys will be issued as part of this new service. **Hobart Brothers Co.**, Troy, Ohio.

» «

History of Piping

From hollow log to welding fittings, the **"Romance of Piping,"** is told in the Spring, 1943, issue of *Sparks*, house magazine of **Tube Turns, Inc.** This unique history is full of interesting and little known bits of information such as: that the use of pipe for conveying steam was known to Egyptian priests; that the queen of ancient Crete (2,000 B.C.) enjoyed bathroom facilities with sanitary plumbing; that the Romans built 359 miles of conduit leading into Rome (of which 304 miles were underground) and used pipe fittings surprisingly similar to those used today, including four-branch fittings or crosses, brass stopcocks and wiped joints; that 25,000,000 people, one-fourth the population of Europe, were destroyed by the Black Death during the Dark Ages when filth flourished unchecked by running water from piping; that London Bridge was the site of a "modern" water pumping station in 1583, and that the first cast iron pipe was made in 1664 to supply water for the famous fountains of Versailles.

No such history as this has existed heretofore; to prepare it, it was necessary to do considerable research in large libraries and even to hire translators for German manuscripts. The information thus secured was boiled down into twenty minutes of interesting reading and well illustrated with authentic drawings and photographs showing the use of piping from the pyramids of Egypt to today. **Tube Turns, Inc.**, 224 East Broadway, Louisville, Kentucky.

» «

Electronic Control Booklet

G-E ignitron contactors for fast power switching of A-C resistance welding machines are described in an 8-page, 8 by 10½ in. bulletin, **GEA-3058B**, issued by the **General Electric Co.**, Schenectady. This bulletin illustrates three standard electronic contactors—150, 300 and 1,200 amp sizes—and tells how they may be used to best advantage for the control of A-C resistance welders.

WHERE 10 DAYS HAD BEEN TOPS...

these Spouts lasted 30!

THAT IS because these pulverizing mill discharge spouts have a hard-facing of Coast Metals. This protecting overlay is exceptionally resistant to the severe abrasive action of the hot clinker mixture that formerly wore out ordinary spouts in less than 10 days' service!

Easily applied by the electric welding arc or the oxy-acetylene torch to any ferrous metal including manganese steel, cast iron and chilled iron, Coast Metals hard-facing is today's wartime answer to making parts employed in tough service last longer. By keeping equipment on the job without unnecessary shutdowns for repair or replacement, it steps up production and improves plant operating efficiency.

Tell us *your* particular wear-resistance problems. Our engineers can help you.

COAST METALS

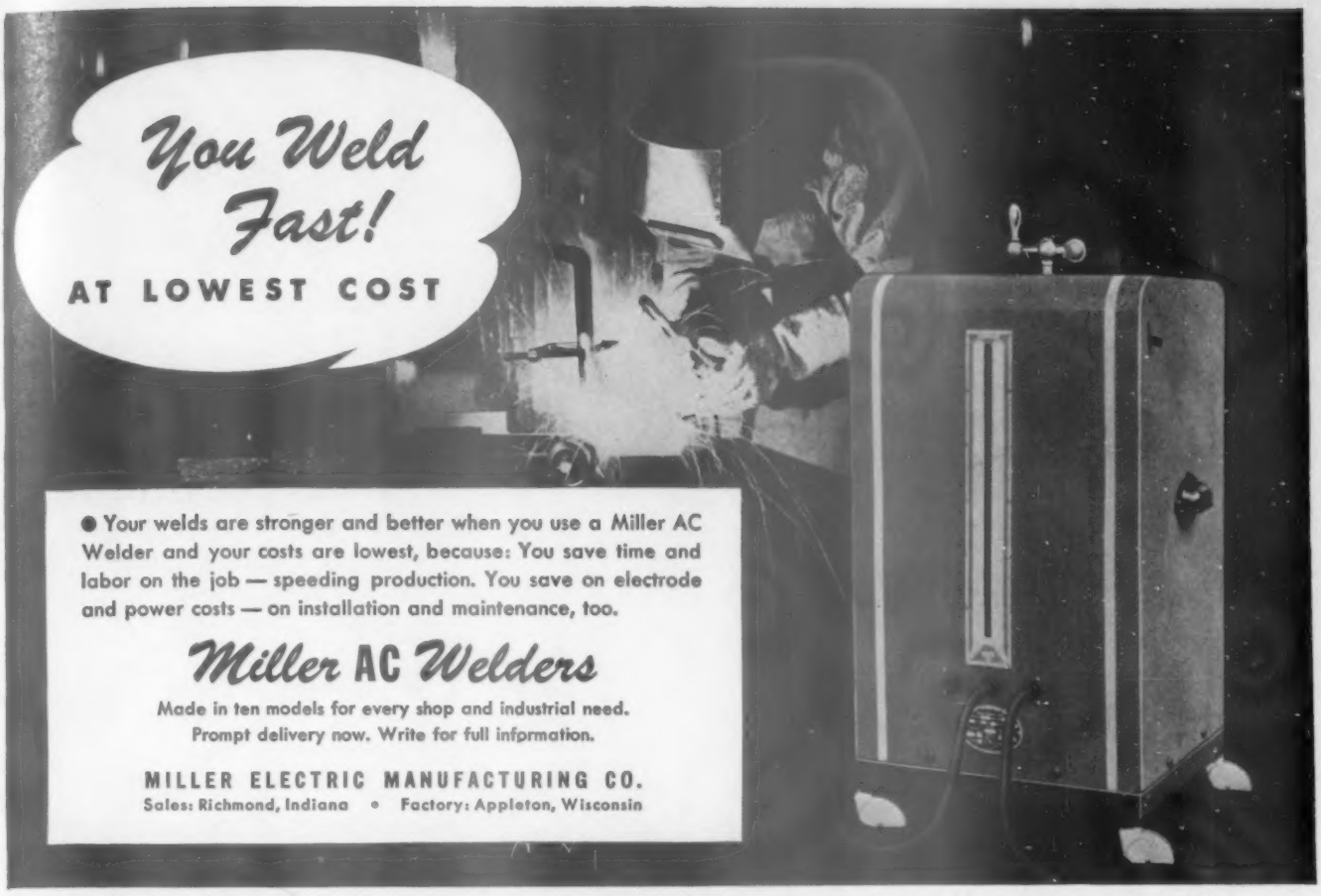
hard-facing weld rods

COAST METALS, INC.

Plant and General Offices: Canton, Ohio

Executive Offices: New York, N.Y.

YOUR EQUIPMENT'S LIFE PRESERVER AGAINST WEAR



● Your welds are stronger and better when you use a Miller AC Welder and your costs are lowest, because: You save time and labor on the job — speeding production. You save on electrode and power costs — on installation and maintenance, too.

Miller AC Welders

Made in ten models for every shop and industrial need.
Prompt delivery now. Write for full information.

MILLER ELECTRIC MANUFACTURING CO.
Sales: Richmond, Indiana • Factory: Appleton, Wisconsin

MILLER AC MEANS STRONGER, BETTER, LOWER-COST WELDS

REGISTERED **MANGANAL** U. S. PAT. OFFICE

11 to 13½% MANGANESE NICKEL STEEL WELDING PRODUCTS

Heel of Bucket Rebuilt with Round Applicator Bars; Shovel Teeth Repointed with Wedge Bars

APPLICATOR BARS
Round, Square, Flat, Special Shape for reclaiming worn Jaw Crushers, Mantles, R.R. Crossings, Dredge Bucket Lips, Tumblers, Pump Shells, Impellors, Dippers, Tractor Tread Grousers, etc.

CAST WEDGE BARS
for making Dipper and Shovel Teeth Repointers, etc.

WELDING ELECTRODES
Bare, Tite-Kote and Special Tite-Kote (for A.C. and D.C.) for building up worn and cracked Manganese Steel Parts —for applying Applicator Bars, Wedge Bars.

Don't Scrap Worn Equipment
—SALVAGE with MANGANAL

STULZ-SICKLES CO. *Sole Producers* 91 N. J. Railroad Ave., Newark, N. J.

Arc Welding Booklet

"Factors Affecting Increased Welding Production" is a new 42-page, letterhead size booklet that contains much up-to-date information concerning various specific phases of arc welding. The booklet is divided into 15 chapters, each of which is an article by E. W. P. Smith, consulting engineer of The Lincoln Electric Co., reprinted from *Steel*. Among topics discussed are: "factors affecting speed and cost," "justifying the amount of equipment for fit-up," "where, when and how to weave," "the automatic carbon arc," "faster welding from larger electrodes," "jigs and fixtures," etc.

This booklet is profusely illustrated and carries many charts and tables that will prove helpful in choosing the correct electrode, applying the most suitable welding technique or estimating the speeds and costs of various welding jobs. It can be obtained directly from **The Lincoln Electric Co.**, 12818 Coit Road, Cleveland.

» «

Brazing Alloy Catalog

Handy & Harman, 82 Fulton St., New York City, announces a revised edition of its general catalog on "Sil-Fos" and "Easy-Flo" brazing alloys. The new catalog, **Bulletin No. 12-A.** is a 20-page, letterhead-size booklet; it gives general information on the process of low temperature brazing with the above-named alloys and discusses many typical applications. A table of brazing alloys conforming to Standard specifications of the Army, Navy, Federal Government agencies, ASTM and SAE is also included.

» «

Aircraft Welding Data

A description of the procedure to be adopted for low temperature welding of chrome-moly steel for aircraft is given in **Bulletin No. 205,** just issued by **Eutectic Welding Alloys Co.,** 40 Worth St., New York City. This process employs welding temperatures of 1,300 F instead of the customary 2,200 to 2,500 F. It is claimed that distortion and overheating are completely avoided, that dissimilar sections or intricate joints with a large variety of shapes can be joined without any ill effects of heat, and that there will be no changes in the structure of the steel because of heating.

» «

Positioner Bulletin

Various models of positioning units and hydraulic elevating welding tables are described in **Bulletin No. 131,** a four-page, letterhead-size circular from the **Lyon-Raymond Corp.,** 1201 Madison St., Greene, N. Y. The tables are used for a great variety of job shop welding, also certain standardized repeat operations. The positioners, which tilt, lift and revolve, put the work in the best position for good downhand welding and thus step up production—in most cases as much as 50%, manufacturer claims.

» «

Symbol Hammer Circular

Information on a plan for permanently identifying the beads produced by each weldor is contained in a 4-page circular just issued by the **Atlas Welding Accessories Co.,** 307 Boulevard Bldg., Detroit. This circular discusses the advantages of the Atlas Symbol Hammer, a combination chipping hammer with symbol insert on its opposite end, and gives data on various identification systems for crews of from 5 to 15,000 weldors.

» «

Steel Analysis Chart

A revised steel analysis chart embraces all modifications and changes in the analyses of AISI, SAE and the new NE steels up to February 1. This chart, which folds up to compact size for convenient reference, covers carbon and free cutting steels, manganese, nickel, nickel-chromium, molybdenum, chromium, chromium-vanadium and silicon-manganese steels, and National Emergency steels. It tells the various forms in which stock products are available and gives the chemical analysis of each steel. A copy may be obtained by writing on a company letterhead to the sales promotion and advertising department of the **American Steel & Wire Co.,** Rockefeller Bldg., Cleveland.

PIERCE-EQUIPPED WELDERS HELP

Keep 'Em in Fighting Trim!

HOW TO MAKE YOUR GOVERNORS LAST!

Like others manufacturing for war needs, Pierce production is for war and essential industry. For this reason new governors can be supplied only on a priority basis. But Pierce calls attention to these easy measures which will make your present Pierce Governors last and give the best service.

- **CLEAN GOVERNORS** once a month with kerosene, gasoline, or prepared cleaner.
- **INSPECT AND CHECK GOVERNORS** each week when in continuous operation.
- **CHECK OIL LEVEL** every day in manually lubricated governors. SAE 20 is recommended at this time of year.
- **LINE UP** driving pulleys or gears accurately when reassembling governor after cleaning.

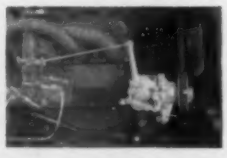
Should your governor need repair or reconditioning send it to the factory with the necessary preference rating certificate.

● When wounded tanks . . . or other fighting equipment crippled in the heat of conflict . . . come in from the battlefields, that's when you need good, strong welds . . . *fast!* And that's just what they're getting over there from the welders in the mobile machine shops which are powered by Pierce-equipped engines! Pierce Flyball Governors bring to these engines the perfect speed regulation required for fast, sure welding. They hold the arc constant, and give split-second recovery of current characteristics . . . within three-tenths of a second after striking arc!

Now . . . and after the war . . . *insist* on Pierce Flyball Governors to regulate your welding operations!

THE PIERCE GOVERNOR COMPANY
1607 OHIO AVENUE, ANDERSON, INDIANA

Pierce Flyball Governors are precision-built, speed regulating devices of absolute dependability. For welder outfits the fan-belt drive is widely used.



Pierce Governors

STANDARD SINCE 1911

WHEN *Exceptional* BEARING PROPERTIES ARE NEEDED — *Wear-Resistant*

AMPCO-TRODE

THE *Only* COATED ALUMINUM BRONZE WELDING ROD

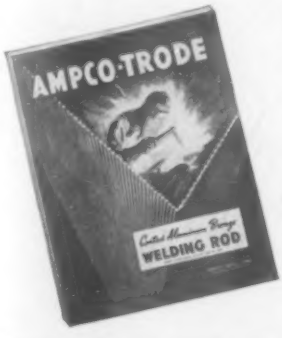
These coated-bronze electrodes have bearing characteristics that make them outstanding as overlays for steel and cast iron. Made of Ampco Metal, these aluminum bronze rods have certain inherent bearing qualities, proved by thousands of applications in the industrial field. Ampco-Trode weldrods are extensively used for building up worn shafts, wear strips and valve seats; overlaying bearing surfaces, and refacing for wear resistance.

Superior Hardness and Strength. With a choice of seven grades with a wide range of hardness—100 to 375 Brinell, you can select an electrode that will exactly meet your requirements; available also in tensile strengths from 60,000 to 80,000 psi. Thus, instead of one electrode with a narrow range of properties, you have a series of electrodes from which to choose.

Seven Grades. Ampco-Trode coated-bronze electrodes are made in 7 grades of physical properties, giving a wide choice in strength and hardness.

Seven Sizes. Sizes range from $\frac{1}{8}$" to $\frac{1}{2}$" in diameter—an economical size for every job.

Welding Methods. Ampco-Trode weldrods can be used by metallic arc, carbon arc, and oxy-acetylene welding.



Free Catalogue. If you are interested in better bronze welding, send for the revised Ampco-Trode catalogue, giving detailed information on electrode properties and welding technique.

AMPCO METAL, INC.
Department WR-4
Milwaukee, Wisconsin

A *Tribute... and a Responsibility*

When the men and women of Stanley Electric Tools, Division of The Stanley Works, received the Army-Navy "E" award on February 13, it was a much prized tribute to a great production team during the one hundredth anniversary year of the Company.

Upon their shoulders has rested a triple burden. They have been called upon to supply (1) tools for the armed forces . . . to construct and maintain camps, bases, and barracks; (2) tools for war industry . . . to build plants, ships, planes, and other implements of war; (3) tools for the home front . . . to maintain farms, schools, institutions and essential civilian industries.

Hand in hand with this honor for past performance goes a great responsibility for future performance. These men and women fully realize this responsibility. Far from being contented with the "contribution to Victory" already made, they are earnestly striving to make an even greater contribution in the future. Stanley Electric Tools, Division of The Stanley Works, New Britain, Connecticut.

1843 STANLEY 1943
TRADE MARK

Flame Color Chart

Prepared particularly for the guidance of new weldors, Airco's recently issued chart for oxy-acetylene flame adjustment is also being welcomed by the old hands. Natural-color photographs convey the proper appearance of the various welding flames faster and more accurately than could any amount of verbal description. The five fundamental flame adjustments pictured are: (1) acetylene burning in air, (2) strongly carburizing flame, (3) slight excess of acetylene flame, (4) neutral flame, (5) oxidizing flame.

Desired quantities of these charts (which contain no advertising) may be obtained on request to the **Air Reduction Co.**, 60 East 42nd St., New York City.

» «

Shift Scheduling Aid

Failure to rotate shifts on an equitable basis may be, at least in part, responsible for much of today's absenteeism. To overcome this difficulty is the **"Shiftograph,"** an instrument designed for use as a perpetual work shift schedule. This is simply a large cutout card with a movable dial; by turning the dial, the user can tell at a glance what shifts certain crews will work, the days they work and their days off. The instrument provides for several different plans of rotation wherein all employees are treated alike by being made to share equally in desirable and undesirable work shifts.

More than 150,000 Shiftographs are being distributed free of charge by the **George S. May Co.**, 2600 North Shore Ave., Chicago, as its contribution to America's war effort. The device has been inspected and approved by Chairman Donald M. Nelson of the War Production Board.

» «

Positioner Leaflet

Increased welding production, time and electrode savings, better, stronger welds—these are the results of positioned welding as explained in a two-page leaflet just issued by the **Ransome Machinery Co.**, Dunellen, N. J. Six welding positioners are pictured, ranging in size from a light-duty, hand-operated model to one of 20-ton capacity.

» «

Pipe Welding Booklet

"The Welding of Piping" is a practical 16-page treatise covering various types of ferrous and non-ferrous pipes, their dimensions, fabrication and estimates of welding and labor costs. Copies may be secured on request to the **Air Reduction Co.**, 60 East 42nd St., New York City.

» «

Tip Maintenance Report

A **field service-special report** from **Oakite Products, Inc.**, 57 Thames St., New York City, covers the reconditioning of oxy-acetylene welding and flame-cutting tips by a recently devised method said to eliminate the possibility of mechanical injury to the orifices. Additional details concerning the process will be found on page 52 of this issue of THE WELDING ENGINEER.

» «

Strain Gauge Booklet

A 28-page, 6 by 3½ in. booklet, **Bulletin 171,** has been issued by the **Baldwin Southwark Div.** of the Baldwin Locomotive Works, Philadelphia, to discuss some of the possible applications for its new SR-4 strain gauges. This gauge consists, fundamentally, of one or a properly oriented group of two or three fine wires cemented to the surface subject to stress change. These are connected to a portable Wheatstone bridge unit, the unbalance of which becomes a measure of stress change. Seven standard types of SR-4 gauges are now available.

» «

Fire Protection Booklet

"Preventing Cutting and Welding Fires" is the title of a 16-page, 5½ by 8½ in. booklet now available at 10c per copy from the **National Fire Protection Association,** 60 Batterymarch St., Boston.

SPEED UP ALL SURFACING WITH
SKILSAW SANDER-GRINDER!
FASTER SANDING!
FASTER GRINDING!
FASTER METAL CLEANING!
FASTER POLISHING!
If you do surfacing—of any kind—you need SKILSAW Model "SL" SANDER-GRINDER in your shop. It's designed for lightness and easiest handling. It's built for constant, trouble-free use . . . powered for faster, better production. And it does more jobs (with sanding discs, grinding wheels, wire brushes, polishing pads) and saves more time on every operation.
SKILSAW Model "SL" SANDER-GRINDER is typical of the entire line of SKILSAW DISC SANDERS. 6 Powerful Models . . . light, compact, perfectly balanced for easier handling and greater speed on every surfacing job. Ask your distributor for a demonstration.
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SKILSAW PORTABLE ELECTRIC TOOLS
★ MAKE AMERICA'S HANDS MORE PRODUCTIVE ★
SKILSAW Model "SL" SANDER-GRINDER speeds up grinding of welding beads. Drives cup grinding wheels, sanding discs and wire brushes at 5,000 R.P.M.

SKILSAW Model "N" DISC SANDER quickly removes fins and scale from gray iron castings. Also buffs and polishes flat or curved surfaces of all materials.

You're Never Caught Short
● With a Sight Feed Generator you never lose your heat in the middle of a job. You always have plenty of acetylene—never have to wait on delivery from a "bottler." And you cut acetylene costs up to 75%.
You see the "charge" in a Sight Feed and your acetylene supply is assured.
You operate any torch at any desired pressure with a Sight Feed Generator.
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GENERATORS
Made in a range of sizes—in portable and stationary models—for all shop and industrial service needs. Sight Feeds are listed for safety by UL and FM. Write for full information.
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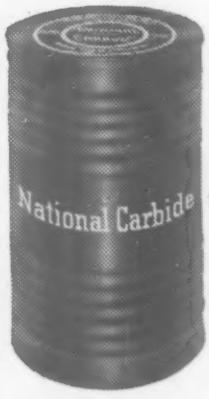

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Welding and Cutting
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WELDER ORDERED!

M·S·A *Comfo*
WELDER'S
MODEL
METAL FUME
RESPIRATOR

U. S. Bureau of Mines-Approved

Designed for use under all types of welding helmets—compact, light in weight, providing approved protection against harmful metal fumes—this special Comfo model clicks with the welder's demand for an efficient metal fume respirator suited to his job. Guarded double-seat exhalation valve, twin side-placed replaceable filters, flexible molded facepiece furnish comfort and service already proved by thousands in use. Write for Bulletin No. CR-8!

MINE SAFETY APPLIANCES CO.
Braddock, Thomas and Meade Streets, Pittsburgh, Pa.
District Representatives in Principal Cities

News of the Industry

Lincoln Has Savings Plan for Postwar Welding Shops

A savings plan to enable workers to start their own private businesses after the war is announced by The Lincoln Electric Co., Cleveland. The participant may employ the Lincoln plan as the key to postwar establishment of such businesses as a commercial weldery, a commercial job welding shop or an automotive welding repair shop.

The worker desiring to participate is sent an application blank for opening a savings account in the Cleveland Trust Co. He is then encouraged to make deposits regularly so that by the time priorities on welding equipment and electrodes are lifted, he will have enough money to purchase an outfit that will start him in business.

As soon as priorities have been lifted, the depositor will then send in his order and notify the Cleveland Trust Co. to turn over the proper amount to Lincoln Electric.

The depositor, of course, may withdraw the money for other purposes should emergency arise. By saving to start his own enterprise, however, Lincoln officials emphasize, he is not only planning for his own future but helping to cushion the shock that will be experienced when the country changes back from war production to normal business pursuits.

» «

Atlas Expands Its Distributor Set-up

Atlas Welding Accessories Co., Detroit, has appointed more than 150 new welding jobbers in the last 90 days to handle its line of weld cleaning tools, electrode holders and other products. The company is now embarking upon an enlarged advertising program designed to coördinate sales, merchandising, sales promotion literature, direct mail, advertising and publicity in building national distribution with outstanding welding supply jobbers.

Electric Arc Celebrates Its Silver Anniversary

Electric Arc, Inc., Newark, N. J., celebrated its 25th anniversary on St. Patrick's Day. The company was organized on that date in 1918, taking over the patents of C. J. Holslag from the Steinback Electric Co. of Peekskill, N. Y.

This company was one of the pioneers in the development of coated electrodes and A-C welding. It is now widening its scope with electric induction heating for preheat, normalizing and stress relief and, in the welding field, with the group Multiple Star system, in which the arc starts on D-C and runs on A-C.

C. J. Holslag has continued as president of Electric Arc, Inc., during its entire 25 years of manufacturing.

» «

Adopt Trust Fund Plan to Share War Profits

United Electronics Co., Newark, N. J., has adopted a trust fund plan under which all of the company's 250 employees will share profits of the war period at the end of the war. This plan is designed to serve the dual purpose of minimizing the turnover of personnel during the war and to provide a nest egg for each employee during the postwar period. To be eligible, an employee must remain with the company until the end of the war unless called into military service.

HERCO VARIABLE CORE ARC WELDERS

MODELS FROM 150 TO 1500 AMPERES WITH OR WITHOUT POWER FACTOR CORRECTION

for:

24 hour per day operation.
Exact heat control.
Increased production.
Lower power costs.
X-ray test welding.
Ease of operation.

Inquire about MAGNETIC CLAMPS for quick positioning and alignment.

HERCULES ELECTRIC & MFG. CO. INC.

MANUFACTURERS OF THE PRECISION WELDER WITH THE STREAMLINED ARC

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MAKE YOUR OWN CUTTING TOOLS

with the new

COLMONOY

W C R ALLOYS

Bridge the gap between high speed steel and the carbides. Reclaim old, and make new cutting tools by welding. The process is simple.

To fabricate a typical tool—

1. **Undercut carbon steel shank, leaving a fillet for ease in welding.**
2. **Fill undercut, using ordinary hard facing welding procedure.**
3. **Hot wipe, to approximate shape, to save grinding.**
4. **Wet grind, using silicon carbide rough and finish wheels.**

WRITE FOR LITERATURE

Immediate delivery of all grades of W C R Alloys at all branches

WALL-COLMONOY CORP.

720 Fisher Bldg., Detroit, Mich.

Branches in New York City, Blasdell, N. Y., Chicago, Tulsa, Los Angeles, and in Canada

FORTIFY POINTS OF EXTRA WEAR WITH

BERGSTROM *Free Flowing*

HARD SURFACING ELECTRODES

IF you operate any equipment on which some surfaces are subject to extra wear, these electrodes can help prevent troublesome breakdown—and save money. They deposit a layer of metal that has extra resistance to abrasion and corrosion. Bergstrom Electrodes flow freely—do not form scale. Easily applied in any position.

WRITE FOR FREE INFORMATION.

We will send you an outline of the specific job each of the six types of Bergstrom Electrodes is designed to do.

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UNITED STATES STEEL SUPPLY COMPANY

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UNITED STATES STEEL

10 HOURS OUTPUT

from every

8 HOUR SHIFT!

with the

BENTLEY WELDING POSITIONER

★ THAT'S a fact. The Bentley Welding Positioner—with variable speed rotation—actually saves 25% of the customary handling labor on the ordinary welding operation. That's the equivalent of 5 men's labor from every 4 men . . . a clear gain of an *extra* man and an experienced man, as well. Think of what that extra production means in these days of manpower shortage. Also, consider the fact that by proper positioning, welders will deposit *more weld metal* per hour, and *produce better* welds.

★ The Bentley Positioner is so simple and so easy to handle that nervous and physical fatigue are held to a minimum. The variable speed control is as easy to use as the accelerator on an automobile— simple toe pressure produces any speed needed for down-hand welding of every inch of the fillet. Welding that's faster, with superior physical properties and neater, cleaner beads.

★ Illustrated above is Model MV-5—Variable speed rotation with manual tilt.
Also available in following models:
Model AV-5—Variable speed rotation with air-actuated hydraulic tilt.
Model AM-5—Manual rotation with air-actuated hydraulic tilt.
Model MM-5—Manual rotation with manual tilt.

★ Write today for full description and prices.

BENTLEY WELDERY, Inc.

SYRACUSE, N. Y.

Data Needed to Help Whip Japs and Nazis

Here is a real way to help the war effort! The Associated Defense Committees of Chicago Technical Societies have issued an urgent request for the names and addresses of all engineers or scientists who have technical information concerning the industries, communication systems, transportation, raw materials, etc. of continental Europe, the Scandinavian countries or any of the Japanese occupied territories. Moving picture films or still pictures showing the coast lines, harbors and industrial centers of such countries are also wanted. Those having such data to contribute are requested to communicate with Robert C. Brown, Jr., chairman of Associated Defense Committees, 53 West Jackson Boulevard, Chicago.

» «

AMA to Hold Production Conference in Cleveland

A conference to discuss the "growing pain" war problems of conversion and of making unfamiliar products will be held at the Hotel Statler, Cleveland, May 5 and 6, under sponsorship of the American Management Association. Particular emphasis will be laid upon the two great problems of today: materials procurement and man-power utilization.

When Parts Must Be Held in Vertical Plane for Drilling or Tapping . . . .

USE THIS KNU-VISE FIXTURE

It's a complete fixture in itself—requiring only special jaws that you can make for the particular job at hand—especially efficient for use when small parts must be held in vertical position for accurate drilling, tapping, reaming, milling, assembly, or other operations that are constantly repeated. Every piece is held in exactly the same position—so each operation is duplicated with absolute precision.

Send for complete catalog with prices

KNU-VISE INCORPORATED

1338 Plum Street, Detroit, Mich.
4328 San Fernando Rd., Glendale, Calif.

ABOUT PEOPLE

Those in our nation's armed forces may continue to read THE WELDING ENGINEER at a special reduced price of $1.50 per year for the duration.

Orville T. Barnett, engineer of tests for Murex electrodes, has been made production engineer for both the arc welding and thermit welding divisions of the Metal & Thermit Corp., New York City. Before joining Metal & Thermit in 1940, Mr. Barnett was in charge of welding and shop inspection for Black, Seville and Bryson, Oklahoma City, Okla.

» «

E. A. Leaverty, purchasing agent of Metal & Thermit Corp., has been made general purchasing agent for the entire organization, including the plants at Jersey City, Carteret and Piscataway, N. J., and at East Chicago and South San Francisco. He has been with Metal & Thermit since 1906.

» «

R. J. Rowen has been appointed manager of the Wheeling, West Va. district of the Air Reduction Co., New York City. He is one of the pioneers with Air Reduction, having started in 1916 as a shipping clerk in the distribution department at Philadelphia. He was appointed assistant manager of the Wheeling district two years ago.

» «

Roberts B. Thomas has been elected secretary of the American Institute of Steel Construction, New York City, to succeed **V. G. Iden,** who has joined the staff of the Bureau of National Affairs of Washington, D. C. Mr. Thomas will continue as general counsel of the Institute, the duties of the two offices having been combined for the duration.

» «

Thomas C. Finnell has been appointed manager of the industrial department, eastern district, of the Westinghouse Electric and Mfg. Co. and will supervise the supplying of electrical equipment to war industries throughout New York state and northern New Jersey. Mr. Finnell has been with Westinghouse since 1929, serving recently as an application engineer in New York City. In his new post, he succeeds **C. W. Miller,** who has been named manager of the application department of the Westinghouse radio division at Baltimore.

» «

Died . . .

Max W. Babb, chairman of the board of the Allis-Chalmers Mfg. Co., Milwaukee, died March 13 in Milwaukee after an illness of several weeks. He had been board chairman since January, 1942, and the company's president for the ten years prior to that date.

RESISTO-LOY

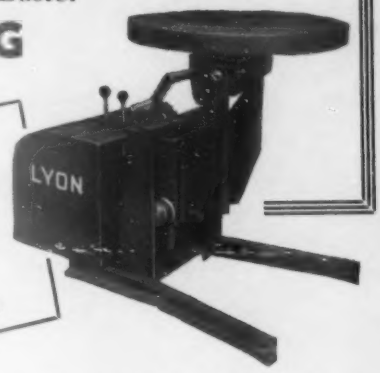
- A non-ferrous alloy of chromium molybdenum, copper, manganese and carbon
- Deposits show extreme resistance to abrasion; withstand severe impact without shattering
- High resistance to acid and alkaline corrosion
- For A.C. or D.C. Arc and Oxy-Acetylene application
- May be applied to all grades of steel and cast iron
- Ideal for setting carbide inserts due to high tensile strength of the deposits, which approach 90,000 psi. Wherever severe impact and abrasion are encountered, use RESISTO-LOY.

ISOROD . . . Self-hardening alloy that is truly foregable and highly abrasion-resistant. Easily applied. Deposits of Isorod can first be controlled for a hard facing metal deposit and then by a slight change in technique, provide a deposit with extremely high tensile strengths for joining parts subject to heavy service.

Write for Application Details and Specifications

THE RESITO-LOY CO.
GRAND RAPIDS, MICH.

Faster, Better, Easier
WELDING
with
LYON-RAYMOND HYDRAULIC WELDING POSITIONER



Here's the new way to improve both quantity and quality of your welding! This new Lyon unit makes experienced welders more efficient . . . helps new operators do reliable work. Positioner reduces crane handling to a minimum—cuts need for helpers—steps up production as much as 50%. For welding complicated or awkward pieces, table may be removed and special holding fixture substituted. Write us *now* for full information about this convenient, labor-saving Lyon unit.

Lifts 14" Hydraulically
Tilts 90° Hydraulically
Revolves 360°—By Hand-crank or Vari-speed Power

LYON-Raymond Corporation
MATERIAL HANDLING EQUIPMENT
226 Madison St. Greene, N. Y.

HOBART *Arc Welding School*
trains quickly, thoroughly

Classes for **MEN** *and* **WOMEN**

Hobart's school is not a war-time offspring. Established long before the war to give experienced operators to the fast growing business of arc welding. ***Instructors Are Expert Welders...*** and they are expert teachers, too. They've all had years of experience showing others the correct procedures of every type of welding.

Send Your Men to Hobart
Many plants send men and women to increase their welding operations.

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"FLAW DETECTION"
in Materials and Products
"INSPECTION *WITHOUT* DESTRUCTION"
SAVES TIME, MATERIALS, EXPENSE

INDUSTRIAL RADIOLOGY
by **ANCEL ST. JOHN** and **H. R. ISENBURGER**
2nd Edition just published

Modern production methods have created modern inspection methods . . . summarized in one magic word, *Radiology*. For example, no longer must you cut up castings to check for flaws or "guess" about the soundness of any material or product. From this book you can learn what radiology is, its uses, what equipment is necessary, how to operate this equipment, how to make inspections and analyze results.

Theoretical data are given only to define practical points. Straightforward, enjoyable, the authors have masterfully written a simple study of a highly important subject. Engineers, metallurgists and others will read and use INDUSTRIAL RADIOLOGY to save time, materials and expense.

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EVER-KLEAR COVER LENS
THIRTEEN YEARS OF PROVEN SERVICE

"VISION FOR VICTORY"

Safeguard your sight. Good sight is a precious possession; take the best possible care of your eyes. Ever-Klear Cover Lens will aid you in doing this. They will not pit or allow molten sparks to fuse on the surface, insuring clear vision at all times.

Employ Ever-Klear Lens for better welding

Size 2x4¼" for arc-welding shields..$2.40 per dozen
Sizes 46½ to 50 M.M., for goggles....35c per pair

F. R. FAULK, DISTRIBUTOR 405 PENN AVENUE PITTSBURGH, PA.

FROM THE PATENT OFFICE

Hard-Facing Rod

2,313,420. **Arthur T. Cape,** Santa Cruz, Calif., assigned to **Coast Metals, Inc.,** Canton, O. Filed July 16, 1942. Issued March 9, 1943.

A ferrous alloy particularly adapted for hard-facing and a welding rod of this alloy. The alloy contains from 2% to 4.25% carbon, from 6% to 28% chromium, from 3% to 10% nickel, from 5% to 10% molybdenum and from 10% to 30% cobalt, the remainder being substantially all iron.

» «

Soldering Flux

2,313,736. **Francis J. Dashner,** Oak Park, Ill., assigned to **American Can Co.,** New York City. Filed Nov. 18, 1941. Issued March 16, 1943.

A liquid rosin flux composition for soldering the seams of can bodies and the like. This flux, said to have improved wetting and solder disseminating characteristics, comprises a resinous material dissolved in a petroleum naphtha solvent as a carrying vehicle.

Gas Welder for Tubes

2,308,850. **James L. Anderson,** Closter, N. J., assigned to **Air Reduction Co., Inc.,** New York City. Filed May 7, 1940. Issued Jan. 19, 1943.

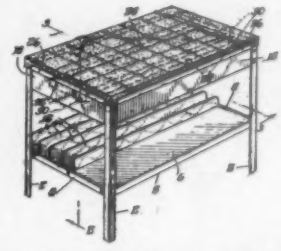
This apparatus for making welded tubes includes a plurality of successive roll stands in which skelp is formed and welded by means of gas flames. The edges of the partially-formed tube are heated with high-intensity flames projected directly against the separated edge faces which are pressed together to make the weld. The length and intensity of the heating is correlated with the speed of the drawbench which pulls the lengths of skelp through the roll stands. Compensation is made for the reduced speed past the flames caused by the diameter reduction in the final roll pass, so that the separated edge faces of the tube blank have been heated to welding temperature by the time they are brought together.

» «

Rustless Iron Electrode

2,310,341. **William Bell Arness,** Bellevue, Pa., assigned to **Rustless Iron and Steel Corp.** Filed June 20, 1938. Issued Feb. 9, 1943.

A welding rod particularly adapted to give a tough, ductile and corrosion-resisting weld which will be free from substantial air-hardening. The approximate analysis is: 8% to 15% chromium, 0.3% to 3% manganese, 0.3% to 3% nickel, 0.3% to 3% molybdenum, 0.02% to 0.07% carbon and the balance substantially iron.

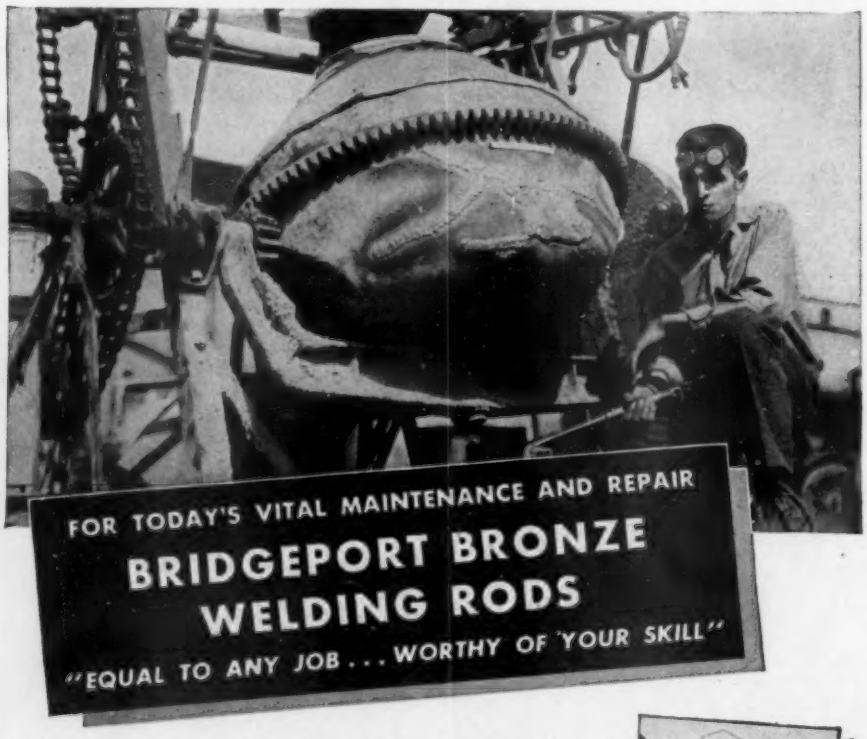


Gas Welding Table

2,310,904. **James E. Bales,** Aurora, Ill. assigned to **Lyon Metal Products, Inc.,** Aurora. Filed Oct. 25, 1941. Issued Feb. 9, 1943.

Each of the four corner legs of this gas welding table has flanges 90 deg apart and lying in a common plane with the flange of another leg. Four sheet metal panel strips are connected by their outer ends to the flanges at the inside walls of the leg; these panel strips provide outwardly extending horizontal flanges and an upwardly extending detaining flange. Angle iron strips are angularly disposed and interconnected to form a substantially hollow rectangular figure providing spaced horizontal flanged walls lying in a common plane with and spaced from the horizontal walls of the panel members. The common plane of the horizontal flanges lies substantially below the tops of the upwardly extending detaining flanges.

Bronze welding does a timely salvage job in war plant construction equipment. Note deep "breaks" skillfully welded with Bridgeport No. 192 low-fuming bronze welding rod.



Maintenance and repair finds Bridgeport Bronze Welding Rods hard at work getting "absentee" equipment back on the job in good working order. For it is recognized that the rod selected must meet all requirements for strong, dense, tough welds. That is why the reliable, workable qualities of Bridgeport Bronze Welding Rods are selected for jobs that must be right.

In replenishing your stock get the best by specifying "BRIDGEPORT" Bronze Welding Rods, the product of 78 years of experience in metallurgical research and development.

FACTS FOR WELDERS ...Practical, up-to-the-minute data. How to select and use bronze welding rods for best results. It is yours free by writing Bridgeport.

BRIDGEPORT BRASS

"Bridgeport" BRASS CO.

BRIDGEPORT BRASS COMPANY
BRIDGEPORT, CONN. • ESTABLISHED 1865

Portable Cutting Machine

2,311,223. **Frank C. Geibig,** Westfield, N. J., assigned to **Union Carbide and Carbon Corp.** Filed April 24, 1940. Issued Feb. 16, 1943.

This patent pertains to the driving mechanism for propelling a cutting or welding torch along a path of travel. The torch or similar tool is carried on a wheel-supported carriage, propelled by an electric motor that is also supported by the carriage. A handle projecting upwardly from the carriage is adapted to be grasped by the hand of an operator; the motor is controlled by means of a switch located within this handle. The switch-operating means projects upwardly from the top of the handle and is movable in forward and backward directions so as to be operable by the thumb of the hand grasping the handle. Guard plates extending from the handle form a channel for guiding the motion of the thumb.

» «

Spot Welding Machine

2,310,556. **George F. Strong,** Grosse Pointe Farms, Mich. Filed April 11, 1941. Issued Feb. 9, 1943.

This patent pertains to a toggle mechanism and covers the combination of: toggle links having pivotally joined ends, an anchorage member pivotally mounting the other end of one of the links, a plunger pivoted to and actuable by the other end of the other link, an arm pivoted to swing in the approximate plane of the links, a link for varying the divergency of the toggle links and extending from the arm to the juncture of the toggle links, a bar pivoted to arm and reciprocatory to actuate it, and a support for the bar pivotal to compensate for the swinging of the arm.

» «

Seam Welding Machine

2,310,557. **George F. Strong,** Grosse Pointe Farms, Mich. Filed April 11, 1941. Issued Feb. 9, 1943.

This patent covers the carriage of a seam welding machine, a work support, means for guiding the carriage in travel along the work support, an electrode movable on the carriage, means for shifting the carriage along its guide and a mechanism actuable by the shifting means for moving the electrode.

» «

Brazing Method

2,310,568. **Zed J. Atlee,** Elmhurst, Ill., and **Howard Brackney,** Chicago, assigned to **General Electric X-Ray Corp.,** Chicago. Filed Jan. 8, 1941. Issued Feb. 9, 1943.

A method of joining a beryllium member to a base member of other metal than beryllium. A brazed joint is formed between the members by melting a brazing alloy comprising copper and silver. The molten copper goes into solution relatively rapidly with the beryllium, and the molten silver goes into solution relatively slowly.

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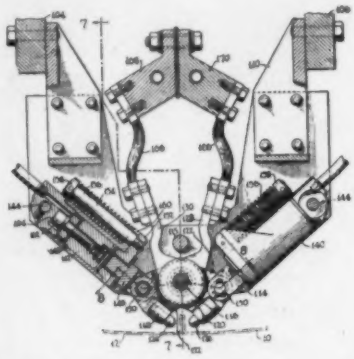
READING, PA. U.S.A.

Spot Welding Gun

2,313,789. **William A. Weightman,** Philadelphia, assigned to **Edward G. Budd Mfg. Co., Philadelphia.** Filed Dec. 7, 1940. Issued March 16, 1943.

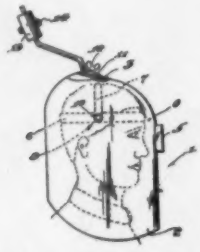


This patent describes a pair of spot welding electrodes which are pivoted to a welding gun support for movement to and from each other. Each electrode is actuated by a means comprising a motor secured to the support and operative to move one of the electrodes toward the other.

» «

Hood Counterbalance

2,309,599. **Bert A. Kinney,** Marshall, Tex. Filed May 20, 1942. Issued Jan. 26, 1943.



This device is designed to assist in raising and lowering a weldor's hood from working to inspection positions. An angular rod is fastened to the upper part of the hood and has a weight on its opposite end. The counterbalance is said to function to raise or lower the hood in response to a movement of the weldor's head alone.

» «

Magnesium Flux

2,311,126. **Percival Robert Charles Pyle,** Warmley, and **Nelson Conroy Sheppard,** Fishponds, Bristol, England, assigned to **Magnal Products, Ltd.,** Warmley. Filed Dec. 23, 1941. Issued Feb. 16, 1943.

This patent pertains to a process for producing fluxes for use in the melting, refining and casting of magnesium and magnesium alloys. An intimate mixture of ammonium chloride, a chloride of an alkaline base, and a basic compound of magnesium is subjected to heat treatment, whereby progressive fusion of the mass results at a temperature below the melting point of the chloride of the alkaline base. The mixture is maintained at about the fusion temperature until all of the ammonia has been driven off.

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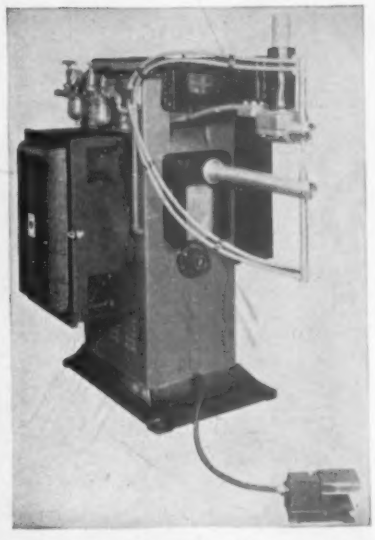

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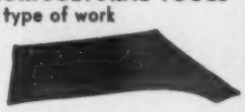
U. S. Patents 2,013,818, 2,051,234 and 2,226,884.



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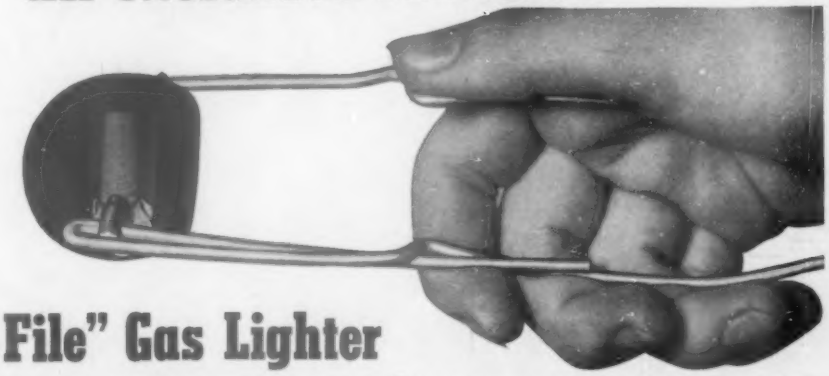

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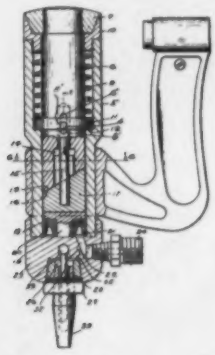
Welding Gun

2,314,320. **Cornelius B. Van Eck,** Grand Rapids, Mich., assigned to **Progressive Welder Co., Detroit.** Filed July 7, 1941. Issued March 16, 1943.



A portable welding gun for "poke" welding which may be readily moved about the plant. It has one electrode, which is forced into position against a back-up bar or the fixture holding the work.

» «

Electrode Holder

2,311,022. **Philip Bourque,** Detroit, assigned to **Bordon Mfg. Co., Inc.,** Detroit. Filed March 3, 1942. Issued Feb. 16, 1943.

This electrode holder has a shank-forming member adapted for connection to an electric conductor, a supporting member on the forward end of the shank-forming portion and a pair of gripping members arranged in superimposed relation and embracing the supporting member at their butt ends. Forwardly of the forward end of the supporting member, gripping members are inwardly offset toward each other; they are normally divergent of each other forwardly of this offset.

» «

A-C Welder

2,310,886. **Edward C. Wentz,** Sharpsville, Pa., assigned to **Westinghouse Electric & Mfg. Co.,** East Pittsburg, Pa. Filed April 29, 1942. Issued Feb. 9, 1943.

Pertaining to a welding transformer, this patent includes a magnetic core structure having five leg members all connected at their ends by two yoke members. The main primary and secondary windings are inductively related to the core. One of the main windings surrounds three of the leg members; the other main winding surrounds one only of the leg members, and two auxiliary windings surround the other two of the three winding leg members. The auxiliary windings are connected in parallel circuit with each other and are so connected in series with the winding surrounding only one winding leg that the voltages of the parallel connected windings are in opposition to the voltage of the main winding surrounding the one winding leg.

» «

Electrode Holder

2,309,886. **Wilbur F. Collins,** Oakland, Calif. Filed April 8, 1942. Issued Feb. 2, 1943.

An electrode holder with a metallic sleeve internally threaded at one end and having a transverse passage at the other end. An insulating sleeve cover extends throughout the length of the metallic sleeve, having an abutting face at one end and at the other end a larger transverse passage in axial registry with the smaller transverse passage in the metallic sleeve. A second metal sleeve covers the insulating cover; this also has a larger transverse passage in axial registry with the smaller transverse passage through the insulating cover. A handle of insulating material has an abutting face at one end and a hexagonal axial passage and radial webs; the intervening spaces between the webs open into the axial passage. A hexagonal conductive member is slidable in the hexagonal passage; this has a threaded radial passage in one side, a cable terminal at one end and a threaded plunger at the other end for coöperation with the internally threaded end of the first metallic sleeve. A wedge block fitting between the radial webs has a longitudinal slot through which a screw passes to engage the threaded radial passage in the hexagonal conductive member. The hexagonal member is adjustable axially in the handle to compensate for various diameters of electrodes.

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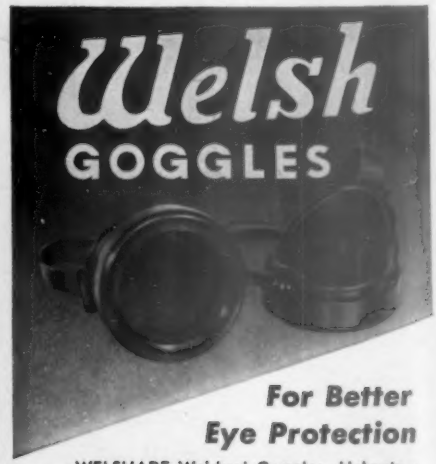

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